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NATIONAL DAM SAFETY PROGRAM. LAKE SHERWOOD DAM (MO 11017), MISS--ETC(U)
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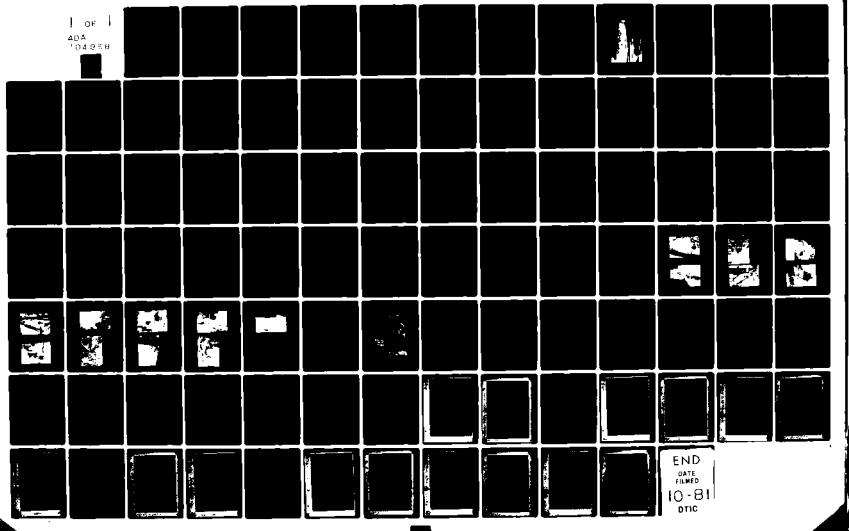

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LAKE SHERWOOD DAM
ST. LOUIS COUNTY, MISSOURI
MO. 11017

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
...Serving the Army
...Serving the Nation

St. Louis District

PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

DECEMBER 1979

~~UNCLASSIFIED~~
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Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

LMSED-P

28 February 1980

SUBJECT: Lake Sherwood Dam (MO 11017) Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Lake Sherwood Dam (MO 11017).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

1. Spillway will not pass 50 percent of the Probable Maximum Flood and is of marginal size to pass the 10 yr. storm.

2. Overtopping of the dam and/or erosion of the spillway could result in failure of the dam.

3. Dam failure significantly increases the hazard to loss of life downstream.

4. Significant erosion is occuring in the discharge channel which is cutting into the right abutment and encroaching on the downstream slope.

SUBMITTED BY: SIGNED
Chief, Engineering Division

28 FEB 1980
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer

28 FEB 1980
Date

LAKE SHERWOOD DAM
ST. LOUIS COUNTY, MISSOURI

MISSOURI INVENTORY NO. 11017

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY
CONSOER, TOWNSEND AND ASSOCIATES, LTD.
ST. LOUIS, MISSOURI
AND
ENGINEERING CONSULTANTS, INC.
ENGLEWOOD, COLORADO
A JOINT VENTURE

UNDER DIRECTION OF
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
FOR
GOVERNOR OF MISSOURI

DECEMBER 1979

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Lake Sherwood Dam, Missouri Inv. No. 11017
State Located: Missouri
County Located: St. Louis
Stream: Headwaters of the River des Peres
Date of Inspection: June 11, 1979

Assessment of General Condition

Lake Sherwood Dam was inspected by the engineering firms of Consoer, Townsend & Associates Ltd. and Engineering Consultants Inc. (A Joint Venture) of St. Louis, Missouri using the "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed by the Chief of Engineers, U.S. Army, Washington, D.C., with the help of Federal and State agencies, professional engineering organizations, and private engineers. The resulting guidelines are considered to represent a consensus of the engineering profession.

The dam appears to be undergoing deterioration on the downstream side. Immediate steps should be taken to correct erosion of the downstream toe due to discharges from the spillway in the right abutment. Immediate steps should be taken to investigate the cause and seriousness of seepage through the central portion of the dam. The dam does not, however, exhibit signs of

structural instability nor is it believed that the safety of the dam is in immediate danger.

Based on the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. The estimated damage zone extends about one mile downstream of the dam. Within the damage zone are a golf course, seven buildings, a school and University City which may be subjected to flooding, with possible damage and/or destruction, and possible loss of life. Lake Sherwood Dam is in the small size classification since it is less than 40 feet high and impounds less than 1,000 acre-feet of water.

Our inspection and evaluation indicate that the spillway of Lake Sherwood Dam does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. Lake Sherwood Dam being a small size dam, with a high hazard potential, is required by the guidelines to pass from one-half of the Probable Maximum Flood to the Probable Maximum Flood without overtopping. Since there is high hazard potential downstream of the dam, the appropriate spillway design flood for this dam is the Probable Maximum Flood. It was determined that the reservoir/spillway system can accommodate only 7 percent of the Probable Maximum Flood without overtopping the dam. Our evaluation indicates that the reservoir/spillway system can not even accommodate the 10-year flood without overtopping the dam. Even though the dam will not pass the 10-year flood, it is reported that this dam has never been overtopped.

The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region. The 10-year flood is defined as a

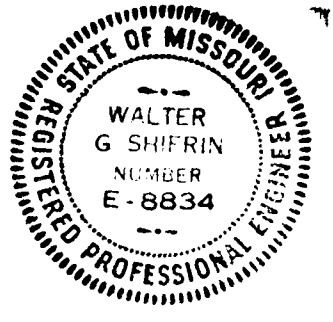
flood having a ten percent chance of being equalled or exceeded during any given year.

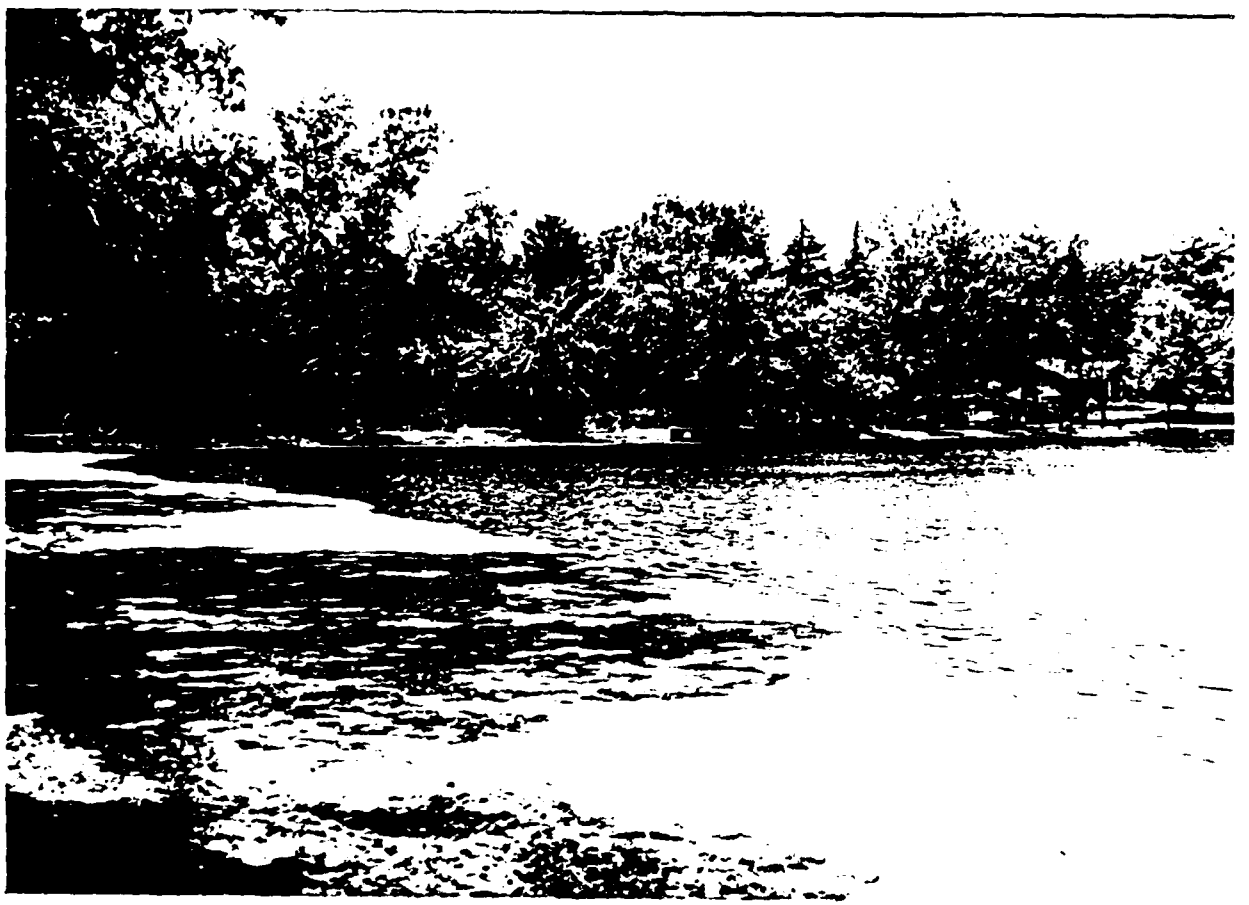
It is recommended that the owner take action to correct the deficiency in the spillway capacity.

Other conditions noted by the inspection team were: brush and trees should be removed from the downstream slope and existing damage to the slope should be repaired.

The absence of seepage and stability analyses is a deficiency which should be corrected. Periodic inspections by a qualified engineer and establishing a maintenance log are recommended.

Walter G. Shifrin, P.E.





Overview of Lake Sherwood Dam

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

LAKE SHERWOOD DAM, I.D. No. 11017

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Lake Sherwood Dam, Missouri Inv. No. !1017

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The *Dam Inspection Act*, Public Law 92-367 of August, 1972, authorizes the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspections. Inspection for Lake Sherwood Dam was carried out under Contract DACW 43-79-C-0075 to the Department of the Army, St. Louis District, Corps of Engineers, by the engineering firms of Consoer, Townsend & Associates Ltd., and Engineering Consultants, Inc. (A Joint Venture), of St. Louis, Missouri.

b. Purpose of Inspection

The visual inspection of Lake Sherwood Dam was made on June 11, 1979. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

This report summarizes available pertinent data relating to the project; presents a summary of visual observations made during the field inspection; presents an assessment of hydrologic and hydraulic conditions at the site; presents an assessment as to the structural adequacy of the various project features; and assesses the general condition of the dam with respect to safety.

Subsurface investigations, laboratory testing, and detailed analyses were not within the scope of this study. No warranty as to the absolute safety of the project features is implied by the conclusions presented in this report.

It should be noted that reference in this report to left or right abutments is as viewed looking downstream. Left abutment or left side of the dam as used in this report refers to the east abutment or side and right to the west abutment or side.

d. Evaluation Criteria

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams", Appendix D. These guidelines were developed with the help of several Federal agencies and many State agencies, professional engineering organizations, and private engineers.

1.2 Description of Project

a. Description of Dam and Appurtenances

It should be noted that design drawings are not available for the dam or appurtenant structures. The following description is based exclusively on observations and measurements made during the visual inspection.

The dam consists of an earthfill embankment between earth abutments. The crest width varies from 66 feet to 75 feet with a length of approximately 500 feet. The elevation of the crest is 611.7 feet above M.S.L. and the maximum embankment height is about 21 feet.

The downstream slope of the embankment was measured to be approximately 1V to 2.25H. A low concrete wall supporting a chain link fence extends along the entire length of the slope at approximately mid height. The remains of a small structure which had housed a latrine is located at the top of the slope at the approximate center of the dam (*shown on* Plate 2). The structure extends some 12 to 15 feet into the dam. A pipe, approximately 2 feet in diameter, can be seen in both the upstream and downstream walls of the structure. A 12 inch diameter cast iron pipe extends from the structure to a 2 foot high stone wall which extends about 40 feet along the toe of the slope.

It was not possible to obtain an accurate measurement of the upstream slope at the time of inspection due to the level of the reservoir. Riprap protection is very sparse. A short concrete wall extends along a portion of the upstream crest in the approximate center of the dam.

Both left and right abutments appear to be natural earth material. Both abutments have good grass protection and each one has a dwelling located on it.

Two 18-inch diameter vitrified clay pipes extend approximately 99 feet from a concrete intake structure, through the right abutment, to a concrete discharge apron. The upstream invert is about 2 feet 2 inches below the embankment crest. The spillway discharges into a channel eroded into natural ground.

A 24-inch diameter conduit extends approximately 124 feet from a concrete intake structure, through the left abutment, and discharges into a channel which has been eroded into natural ground. While the upstream portion of the conduit is concrete the downstream end is corrugated metal. The upstream invert is about 3 feet 8 inches below the embankment crest.

b. Location

Lake Sherwood Dam is located at the headwaters of the River des Peres in St. Louis County, Missouri. The nearest downstream community is University City, a suburb of St. Louis, and is located less than one mile from the dam. The dam and lake are shown on the Clayton, Missouri Quadrangle Sheet (7.5 minute series) in Section 28, Township 46 North, Range 6 East (Plate 1, Appendix B).

c. Size Classification

According to the "Recommended Guidelines for Safety Inspection of Dams", by the U.S. Department of the Army, Office of the Chief Engineer, the dam is classified in the dam size category as being "Small" since its storage is less than 1,000 acre-feet. The dam is also classified as "Small" in dam size category because its height is less than 40 feet. The overall size classification is, accordingly, "Small" in size.

d. Hazard Classification

The dam has been classified as having "High" hazard potential in the National Inventory of Dams on the basis that in the event of failure of the dam or its appurtenances, excessive damage could occur to downstream property together with the possibility of the loss of life. Our findings concur with this classification. The estimated damage zone extends approximately one mile downstream to University City and takes in a school, seven buildings and a golf course.

e. Ownership

Lake Sherwood Dam is owned privately by the Lake Sherwood Homeowners Association. The mailing address is Lake Sherwood Homeowners Association, c/o E. J. Herman, Trustee, 77 East Sherwood, Overland, Missouri, 63114.

f. Purpose of Dam

The main purpose of the dam is to impound water for recreational use in a residential community.

g. Design and Construction History

According to Mr. Dewitt James, a trustee of the Homeowners Association, the dam was constructed in 1894 and is believed to have been constructed for esthetics and recreation by the Sherman family. No plans or construction records were available.

h. Normal Operational Procedures

There are no procedures set forth for the operation of Lake Sherwood Dam. The water level is controlled by rainfall, runoff, evaporation, seepage and unregulated spillway releases.

1.3 Pertinent Data

a. Drainage Area (square miles):	0.19
b. Discharge at Damsite	
Estimated experienced maximum flood (cfs):	NA
Estimated ungated spillway capacity at top of dam elevation (cfs):	34
c. Elevation (Feet above MSL)	
Top of dam:	611.7
Spillway crest:	
Left Spillway	611.0
Right Spillway	611.0
Normal Pool:	611.0
Maximum Pool (PMF):	613.06
d. Reservoir	
Length of pool with reservoir at top of dam elevation (Feet):	1300
e. Storage (Acre-Feet)	
Top of dam:	89
Spillway crest:	
Left Spillway	80
Right Spillway	80
Normal Pool:	80
Maximum Pool (PMF):	113
f. Reservoir Surface (Acres)	
Top of dam:	13
Spillway crest:	
Left Spillway	12

Right Spillway	12
Normal Pool:	12
Maximum Pool (PMF):	14

g. Dam

Type:	Earth
Length:	500 feet
Structural Height:	21 feet
Hydraulic Height:	21 feet
Top width:	66 to 75 feet
Side slopes:	
Downstream	1.0V to 2.25H
Upstream	Indeterminate at time of inspection
Zoning:	Unknown
Impervious core:	Unknown
Cutoff:	Unknown
Grout curtain:	Unknown

h. Diversion and Regulating Tunnel None

i. Spillway

Type:	
Left Spillway	Drop inlet spillway, Uncontrolled
Right Spillway	Drop inlet spillway, Uncontrolled
Length of weir:	
Left Spillway	17.0 feet (Drop inlet spillway with 2 feet diameter concrete pipe)
Right Spillway	9.8 feet (Drop inlet spillway with 2-18 inch diameter clay pipes)

Crest Elevation (feet above MSL):

Left Spillway	611
Right Spillway	611

j. Regulating Outlets None

SECTION 2 : ENGINEERING DATA

2.1 Design

No design drawings or data are available for Lake Sherwood Dam.

2.2 Construction

According to Mr. James, the dam was constructed in 1894. No construction records or as built drawings were available. The source of the embankment materials is unknown, however, it is probable that soils within the immediate area of the dam were used.

2.3 Operation

No operation records are available for the Lake Sherwood Dam.

2.4 Evaluation

a. Availability

The availability of engineering data is poor and consists only of State Geological Maps and U.S.G.S. Quadrangle Sheets. No information on subsurface investigations or soil testing was available. No information on design hydrology or hydraulic design was available, nor were seepage and stability anaylses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams", which is considered a deficiency.

A copy of a report describing in part, the history of the dam was in the possession of the trustees of the Lake Sherwood Homeowners Association. However, the report was not made available to the inspection team.

b. Adequacy

The conclusions presented in this report are based on field measurements, the available engineering data, past performance and present condition of the dam. The data available is inadequate to evaluate the hydraulic and hydrologic capabilities of the dam. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions and made a matter of record.

c. Validity

Not applicable, as no design or construction records were available.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

A visual inspection of Lake Sherwood Dam was made on June 11, 1979. The following persons were present during the inspection:

Name	Affiliation	Disciplines
David J. Kerkes	Engineering Consultants, Inc.	Soils
Peter Howard	Engineering Consultants, Inc.	Geology
Mark R. Haynes	Engineering Consultants, Inc.	Civil, Structural and Mechanical
Kenneth L. Bullard	Engineering Consultants, Inc.	Hydraulics and Hydrology
Kevin J. Blume	Consoer, Townsend & Assoc., Ltd.	Civil and Structural
Dewitt A. James	Lake Sherwood Assoc.	Trustee

Specific observations are discussed below.

b. Dam

Structurally the dam appears to be in satisfactory condition. The crest of the dam had a well maintained cover of grass. Many trees were growing along the crest. There was no evidence of significant settlement or cracks on the crest. No significant deviations in horizontal or vertical alignment were apparent. Even though the dam will not pass the ten year flood, it has reportedly never been overtopped. Material exposed immediately below the vegetation cover on the embankment appeared to be a clayey silt.

The upstream slope was only partially visible for inspection due to high reservoir level. There was no vegetation or trees growing on the upstream slope. Riprap protection was minimal and minor erosion has occurred along the crest due to wave action. There were no readily apparent signs of past or present distress in the upstream slope. There was no evidence of an upstream stone wall, with two 24 inch diameter pipes near the top, reported by Mr. James to have been part of the original construction.

Considerable erosion has occurred along the downstream edge of the crest. Heavy vegetation and trees are growing along the entire downstream slope which hampered a comprehensive inspection of the slope. While there were no signs of slope movement, erosion has occurred in numerous areas due to storm runoff. The entire slope appeared to be quite irregular. The remains of a small structure which had housed a latrine is located at the downstream edge of the crest at the approximate center of the dam. The structure extends some 12 to 15 feet into the dam and seepage could be

observed flowing through the base and apparently exiting above the toe and beneath a low stone wall which extends along a portion of the toe of the downstream slope. Seepage was observed flowing beneath a 25 foot section of this wall at a rate of approximately 8 gpm. The discharge appeared to be clean. No seepage was apparent above or along the toe in any other location. An erosion gulley has formed as a result of discharges from the outlet in the right abutment and is encroaching on the downstream slope in this area. A very small amount of seepage was observed along the contact between the embankment fill and natural ground of the right abutment in the eroded gulley.

Both the left and right abutments were at approximately the same elevation as the crest of the dam. Both abutments appeared to be natural earth material with good grass protection. No erosion or cracking was observed in either abutment along the embankment contact. No seepage was observed in or around the left abutment while minor seepage was discovered in the erosion gulley from the outlet in the right abutment as described above. No evidence of slope movement was apparent in either abutment. Both the left and right abutments each have one sewer manhole located in them. The manholes belong to the Metropolitan St. Louis Sewer District.

There were no readily apparent signs of damage to either the embankment or abutments due to burrowing animals at the time of the inspection. While we were informed by Mr. James that a problem does exist, he also stated that attempts have been made to control the problem by trapping the animals.

c. Project Geology

The regional geologic setting of the dam is on a monocline dipping gently, approximately 30 - 50 ft./mi. to the northeast off of the Ozark uplift which lies to the south ("Geologic Map of Missouri", 1979). While there is no known structure under the site there is a major anticline and associated syncline some six miles to the southeast ("Structural Features Map of Missouri", 1971). It is not known if these structures affect the attitude of the beds at the site.

The rocks underlying the site are, according to published sources, believed to be sandstone and shale of the Pleasanton Group (Pennsylvanian). The bedrock is immediately overlain by 30-50 feet of clayey loess and this in turn overlain by 5-10 feet of silty loess (Engineering Geology of St. Louis County, Missouri, 1971). Plate 3 is a portion of the Geologic Map of Missouri (1979) and shows the location of the dam.

d. Appurtenant Structures

(1) Spillways

Two 18-inch diameter vitrified clay pipes extend approximately 99 feet through the right abutment to a concrete discharge apron. The right conduit appeared to be obstructed. The upstream invert is about 2 feet 2 inches below the embankment crest. Discharge from the spillway has eroded a channel into natural ground and is encroaching on the downstream slope. Undermining of the concrete apron has also occurred. Considerable cracking was observed in the concrete apron due to the undermining.

A 24-inch diameter conduit extends approximately 124 feet from a concrete intake structure, through the left abutment, and discharges into a channel which has been eroded into the abutment. The upstream portion of the conduit is concrete and the downstream end is corrugated metal. The upstream invert is about 3 feet 8 inches below the embankment crest. While discharge from the outlet has caused additional erosion of the channel, the channel is far enough downstream of the embankment not to jeapordize the safety of the structure. The conduit was discharging a minimal amount of flow apparently due to leakage at some point into the conduit. The discharge was less than 1 gpm.

(2) Outlet Works

There is apparently no low level outlet for Lake Sherwood Dam according to Mr. James.

e. Reservoir Area

The water surface elevation was approximately 608.7 feet above MSL on the day of the inspection.

The slopes along the reservoir rim are gentle with good grass protection. No evidence of past or present instability of the slopes was readily apparent. Numerous dwellings are located along the rim.

f. Downsteam Channel

The eroded channels previously discussed converge downstream of the dam near its center. The downstream channel is well defined but rather narrow. No major obstacles or debris were observed along the channel. No significant erosion of the channel was noted.

3.2 Evaluation

The visual inspection did not reveal any conditions which were felt to pose an immediate threat to the safety of the structure, however, certain conditions do exist which warrant prompt attention.

1. Seepage occurring near the downstream toe in the approximate center of the dam, may pose a danger to the safety of the dam. Seepage may wash out materials from the dam embankment.

2. Erosion channel in the right abutment encroaching on the downstream slope, poses a threat to the structural integrity of the dam.

The following items were observed which could affect the safety of the dam or which will require maintenance within a reasonable period of time.

1. The downstream slope of the embankment and hence the stability of the dam may be affected if the surface erosion observed on the downstream slope is allowed to continue.

2. The service spillways were not provided with trashracks. The service spillways may be subject to clogging with debris during a flood.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

There are no procedures set forth for the operation of Lake Sherwood Dam. The water level is controlled by rainfall, runoff, evaporation, seepage and unregulated spillway releases. The reservoir has an aeration system installed and operated by the owners.

4.2 Maintenance of Dam

Lake Sherwood Dam is maintained by the trustees and homeowners who live in the immediate area around the lake. Maintenance is performed as needed, however, it appears to be inadequate. Attempts were made, about 1973 or 1974, to stop the seepage through the dam but they were only temporarily successful.

4.3 Maintenance of Operating Facilities

The only operating facility at the damsite is the small aeration pump located on the crest near the left abutment. The trustees check the small motor and compressor periodically to make certain it is operating.

4.4 Description of Any Warning System in Effect

There is no warning system in effect for Lake Sherwood Dam.

4.5 Evaluation

The maintenance procedures as they exist at this time do not appear to meet the needs of the structure. No steps are taken to control erosion on the downstream slope or the heavy vegetative cover which the slope supports. The spillway in the right abutment was found to be in a state of disrepair and discharges from this spillway are eroding the downstream toe of the embankment. No attempts are being made to monitor seepage through the dam.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design

The watershed area of Lake Sherwood Dam upstream from the dam axis consists of approximately 121 acres. The watershed area is urbanized with about 50 percent of the area in open space and park. Land gradients in the higher regions of the watershed average roughly 4 percent, and in the lower areas surrounding the reservoir average about 5 percent. The Lake Sherwood Reservoir is located on River des Peres about 1/2 mile downstream from the extreme headwaters. At its longest arm the watershed is approximately 1/4 mile long. A drainage map showing the watershed area is presented as Plate 1 in Appendix B.

Evaluation of the hydraulic and hydrologic features of Lake Sherwood Dam was based on criteria set forth in the Corps of Engineers' "Recommended Guidelines for Safety Inspection of Dams", and additional guidance provided by the St. Louis District of the Corps of Engineers. The Probable Maximum Flood (PMF) was calculated from the Probable Maximum Precipitation (PMP) using the methods outlined in the U.S. Weather Bureau Publication, Hydrometeorological Report No. 33. The probable maximum storm duration was set at 24 hours, and storm rainfall distribution was based on criteria given in EM 1110-2-1411 (Standard Project Storm). The SCS method was used for deriving the unit hydrograph, utilizing the Corps of Engineers' computer program HEC-1 (Dam Safety Version). The

unit hydrograph parameters are presented in Appendix B. The SCS method was also used for determining loss rate. The hydrologic soil group of the watershed was determined by use of published soil maps. The hydrologic soil group of the watershed and the SCS curve number are presented in Appendix B. The curve number, the unit hydrograph parameters, the PMP index rainfall and the percentages for various durations were directly input to the HEC-1 (Dam Safety Version) computer program to obtain the PMF hydrograph. The computed peak discharges of the PMF and one-half of the PMF are 2,746 cfs and 1,373 cfs, respectively.

Both the PMF and one-half of the PMF inflow hydrographs were routed through the reservoir by the Modified Puls Method also utilizing the HEC-1 (Dam Safety Version) computer program. The reservoir was assumed at the spillway crest level at the start of the routing computation. The peak outflow discharges for the PMF and one-half of the PMF are 2,152 cfs and 1,053 cfs, respectively. Both the PMF and one-half of the PMF, when routed through the reservoir result in overtopping of the dam.

The stage-outflow relation for the spillway was prepared from field notes and sketches prepared during the field inspection. The reservoir stage-capacity data were based on the U.S.G.S. Clayton, MO. Quandrangle topographic map (7.5 minute series). The spillway and overtop rating curve and the reservoir capacity curve are presented as Plates 2 & 3 respectively in Appendix B.

From the standpoint of dam safety, the hydrologic design of a dam aims at avoiding overtopping. Overtopping is especially dangerous for an earth dam because the downrush of waters over the crest can erode the dam embankment and release

all the stored water suddenly into the downstream floodplain. The safe hydrologic design of a dam requires a spillway discharge capability, in combination with an embankment crest height that can handle a very large and exceedingly rare flood without overtopping.

The Corps of Engineers designs its dams to safely pass the Probable Maximum Flood that is estimated could be generated from the upstream watershed. This is the generally accepted criterion for major dams throughout the world, and is the standard for dam safety where overtopping would pose any threat to human life. According to the Corps' criteria, the hydrologic requirement for safety for this dam is the capability to pass from one-half of the Probable Maximum Flood to the Probable Maximum Flood without overtopping.

b. Experience Data

No records of reservoir stage or spillway discharge are maintained for this site.

c. Visual Observations

Observations made of the spillway during the visual inspection are discussed in Section 3.1c(1) and evaluated in Section 3.2.

d. Overtopping Potential

As indicated in Section 5.1a, both the Probable Maximum Flood and one-half of the Probable Maximum Flood, when routed through the reservoir, resulted in overtopping of the dam. The peak outflow discharges for the PMF and one-half of the PMF are 2,152 cfs and 1,053 cfs, respectively. The maximum discharge capability of the spillways before overtopping the dam is about 34 cfs. The PMF overtopped the dam crest by 1.36 feet and one half of the PMF overtopped the dam crest by 0.76 feet. The total duration of embankment overflow is 11.42 hours during the PMF, and 7.08 hours during one-half of the PMF. The spillways and the reservoir of Lake Sherwood Dam are capable of accommodating a flood equal to about 7 percent of the PMF just before overtopping the dam.

The computed one percent and ten percent chance floods using 100- and 10- year, 24 hour rainfall data, were routed through the reservoir. The routing results indicate that the 100-year flood and the 10-year flood will overtop the dam by 0.28 feet and 0.03 feet respectively.

The failure of the dam could cause extensive damage to the property downstream of the dam and possible loss of life. The estimated damage zone extends about one mile downstream of the dam. Within the damage zone are several buildings, a golf course, a school and University City.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

There are no signs of embankment sloughing, local slides or slumps on the downstream side, however, considerable erosion has occurred along the downstream slope and along the crest. The upstream side of the embankment was almost completely under water and was not accessible for visual inspection. Minor erosion is occurring as a result of wave action. The seepage in the central portion of the dam, described in Section 3.1-b., has not been monitored by the owner and no information was uncovered concerning its age or flow rate. There was no evidence of slides or seepage in either abutment.

Considerable erosion is occurring in the discharge channel of the 24-inch diameter outlet in the left abutment, however, in its present condition it does not jeopardize the safety of the structure. Significant erosion is occuring in the discharge channel of the two 18-inch diameter conduits in the right abutment as well as undermining of the discharge apron. This erosion is cutting into the right abutment and encroaching on the downstream slope.

b. Design and Construction Data

No design computations were uncovered during the report preparation phase. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available. No embankment or foundation soil parameters are available for carrying out a conventional stability analysis on the embankment. No construction data or specifications relating to the degree of embankment compaction are available for use in a stability analysis.

c. Operating Records

No operating records are available relating to the stability of the dam. According to the owner's representative, the embankment has served satisfactorily since it was constructed with no history of problems, to the best of his knowledge.

d. Post Construction Changes

There are no records of post-construction changes. The resident on the left abutment reportedly added the 24-inch diameter corrugated metal pipe to the existing concrete pipe about 3 years ago. From the visual inspection, however, no evidence could be found of the stone wall on the upstream side with two 24 inch diameter pipes near the top which were reportedly part of the original construction. A map obtained from the Metropolitan St. Louis Sewer District, revised in 1971, shows a 419 foot long, 8-inch diameter vitrified clay sewer line extending through the dam and connecting to the manholes in each abutment. It is not known to what depth the line is buried in the dam. In about 1973 or 1974 the dam was

grouted from the upstream side in an attempt to stop seepage through the dam, however, the seepage was only temporarily halted.

e. Seismic Stability

The dam is located in seismic Zone 2, as defined in "Recommended Guidelines for Safety Inspection of Dams" as prepared by the Corps of Engineers. An earthquake of the magnitude expected in a Seismic Zone 2 should not cause significant distress to a well designed and constructed earth dam.

SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation, however, the investigation is intended to identify any need for such studies.

It should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team.

It is also important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there by any chance that an unsafe condition could be detected.

a. Safety

The spillway capacity of Lake Sherwood Dam was found to be "Seriously Inadequate". The spillway/reservoir system will accommodate only 7 percent of the PMF without overtopping the dam. The spillway/reservoir system can not even accommodate the 10-year flood without overtopping the dam.

No quantitative evaluation of the safety of the embankment can be made in view of the absence of seepage and stability analyses. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions and made a matter of record. The present embankment, however, has reportedly performed adequately since its construction without failure or evidence of instability. The dam has reportedly never been overtopped and no evidence was uncovered indicating the contrary.

b. Adequacy of Information

The conclusions presented in this report are based on the available engineering data, past performance and present condition of the dam. Information on the design hydrology, hydraulic design, and the operation and maintenance of the dam as well as seepage and stability analyses were not available. To supplement available data and allow for a more definite evaluation of the dam, it is recommended that the following programs be initiated.

1. Annual inspection of the dam by a professional engineer experienced in the design and construction of earthen dams should be made and this inspection report made a matter of record.

2. Set up a maintenance schedule and log all visits to the dam for operation, repairs and maintenance.

3. Perform seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams".

c. Urgency

A program should be developed as soon as possible to monitor at regular intervals the deficiencies described in this report. The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. The item recommended in paragraph 7.2a should be pursued on a high priority basis.

d. Necessity for Phase I Inspection

Based on results of the Phase I inspection, and if the remedial measures recommended in Paragraph 7.2 are undertaken as specified, a Phase II inspection is not felt to be necessary.

7.2 Remedial Measures

a. Alternatives:

1. Spillway capacity and/or height of the dam should be increased to accommodate the PMF without overtopping the dam. The overtopping depth during the occurrence of the PMF, stated elsewhere in this report, is not the required or recommended increase in height of the dam.

2. Action should be taken to determine the cause or causes of the observed seepage (i.e. rodent holes, decayed roots, original buried pipes, foundation, etc.), and the seriousness of the situation. Properly positioned

observation wells are suggested for this purpose. The investigation should be carried out under the direction of a qualified professional engineer.

3. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of dams.

b. O & M Procedures:

1. The discharge from the spillway in the right abutment should be redirected and properly controlled to prevent erosion. The existing erosion channel should be back-filled with suitable material and properly compacted where it undermines the right abutment or encroaches on the downstream slope.

2. All brush and trees should be removed from the downstream slope to avoid problems which may develop from their roots. Removal of large trees should be under the guidance of an engineer experienced in the design and construction of earthen dams. Indiscriminate clearing could jeopardize the safety of the dam.

Damage to the downstream slope which presently exists or may be caused by the removal of brush and trees should be repaired by proper compaction of suitable material. The slope should then be seeded to develop a growth of grass to protect against future erosion.

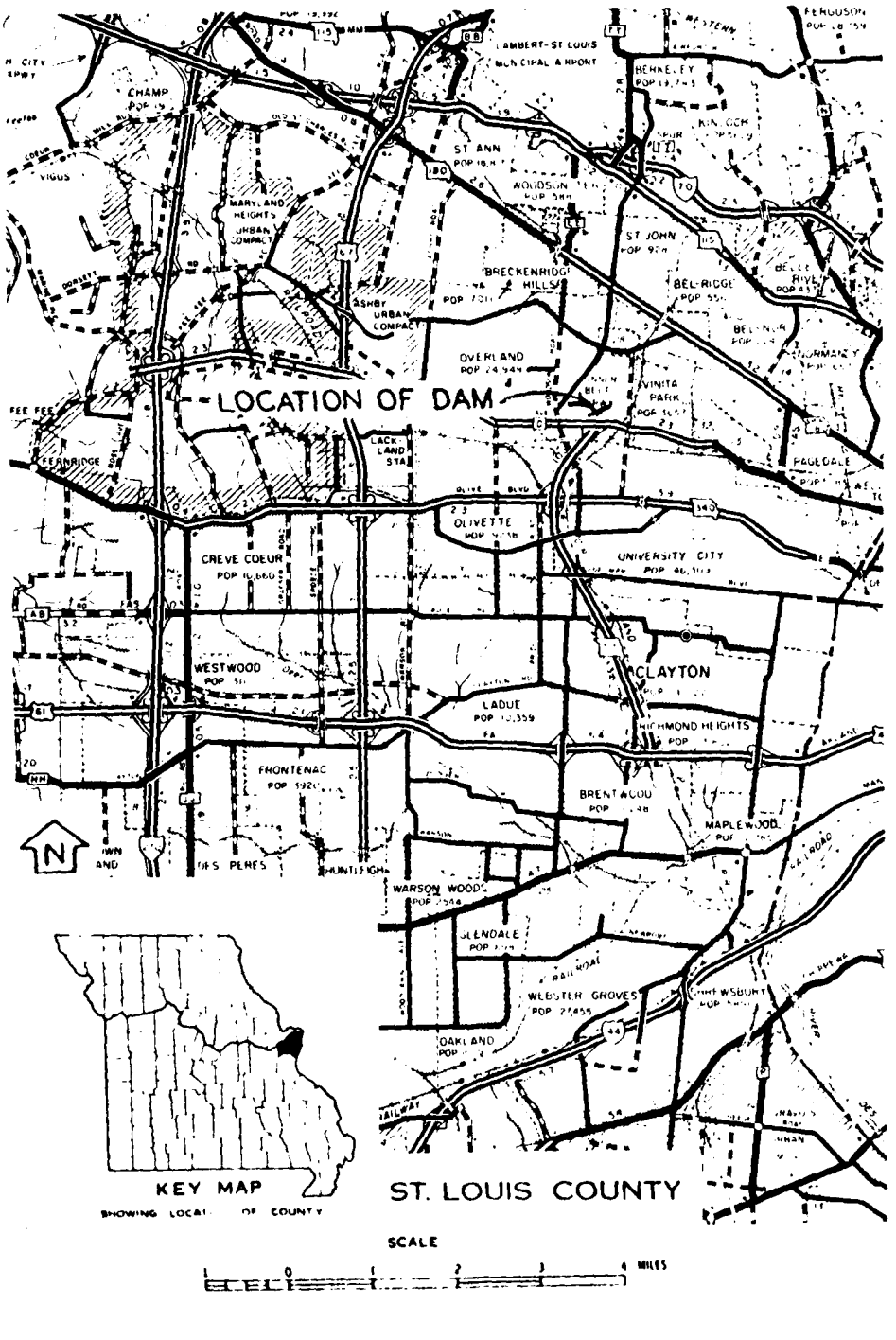
3. The owner should initiate the following programs:

   (a) Periodic inspection of the dam by a professional engineer experienced in the design and construction of earthen dams.

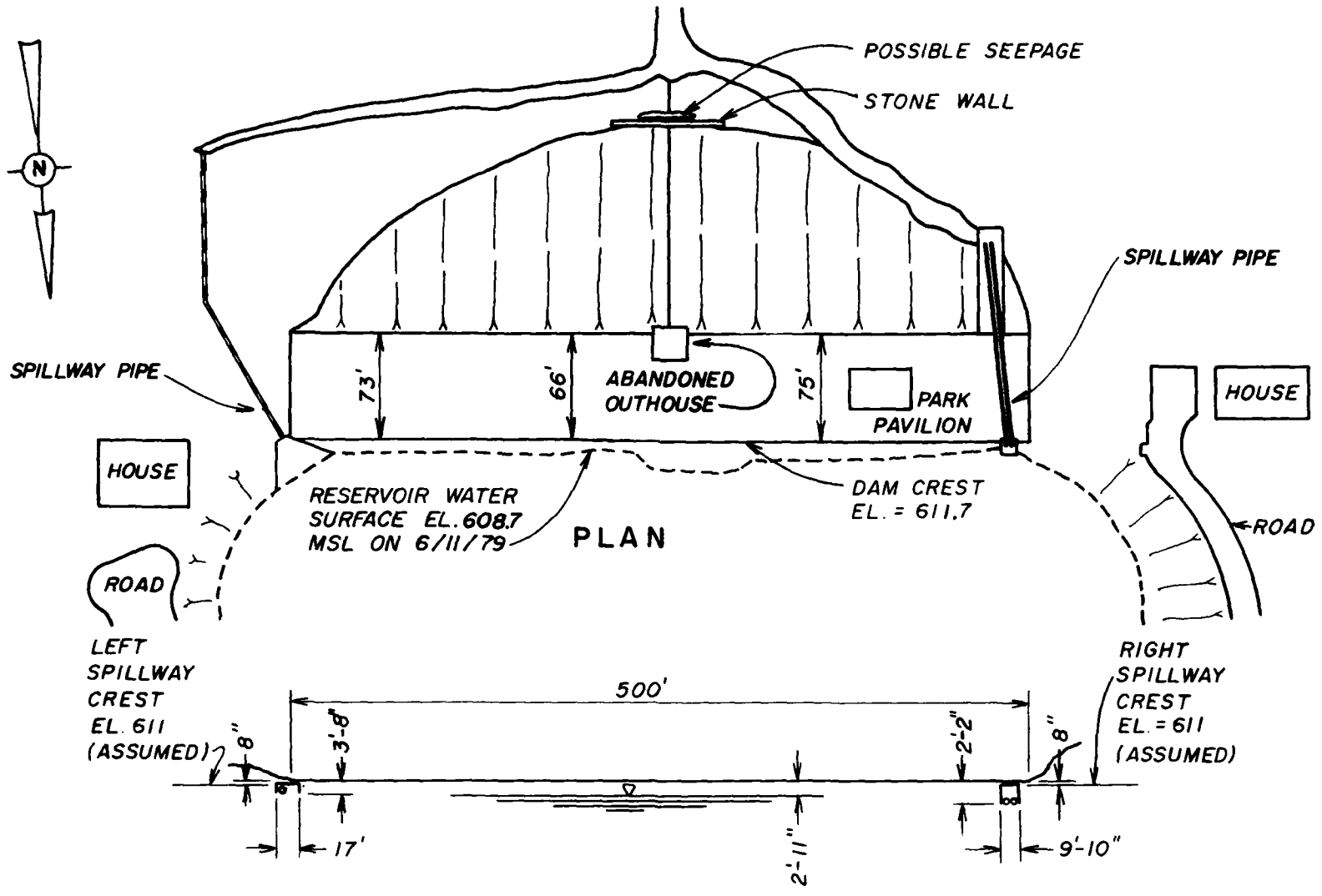
   (b) Set up a maintenance schedule and log all visits to the dam for operation, repairs and maintenance.

PLATES

PLATE I



LOCATION MAP-LAKE SHERWOOD DAM

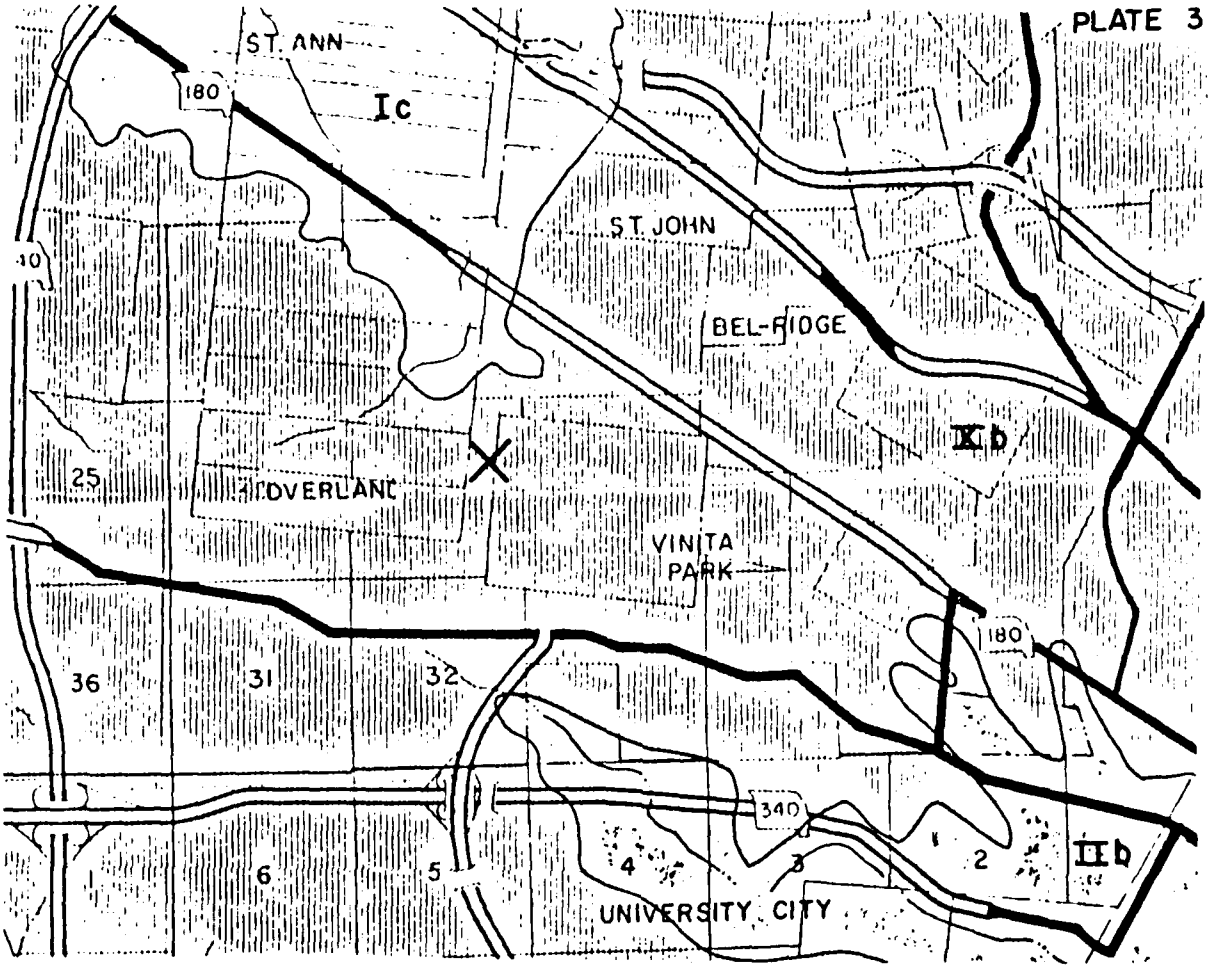


LAKE SHERWOOD DAM (MO. 11017)
PLAN & ELEVATION

P-3

PLATE 2

PLATE 3



Ic - ALLUVIUM, LACUSTRINE (QUARTERNARY)

IIb - 0-10' SILT RICH LOESS OVER 10'-50' CLAY RICH LOESS UNDERLAIN BY RESIDUAL SOIL & CARBONATE BEDROCK (MISSISSIPPIAN)

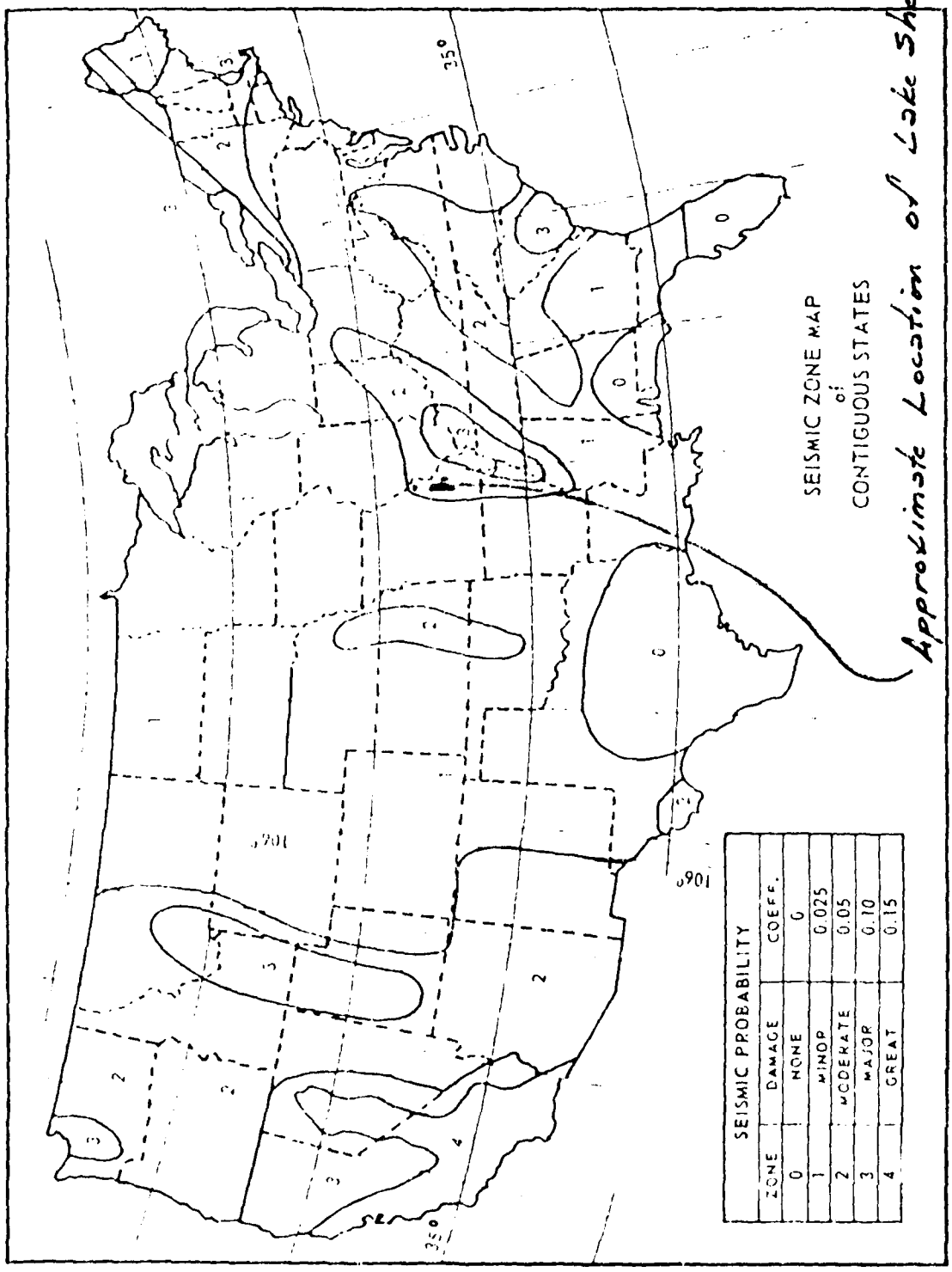
X - LOCATION OF DAM, MO. 11017

IXb - 5'-10' SILT RICH LOESS OVER 30'-50' CLAY RICH LOESS UNDERLAIN BY RESIDUAL SOIL & BEDROCK OF CYCLIC DEPOSITS (PENNSYLVANIAN)

REFERENCE:
ENGINEERING GEOLOGY OF ST. LOUIS COUNTY, MISSOURI, 1974

ENGINEERING GEOLOGIC MAP OF PART OF ST. LOUIS COUNTY, MISSOURI

PLATE 4


SEISMIC ZONE MAP
of
CONTIGUOUS STATES
Approximate Location of Lake Sherwood Dam.
SEISMIC PROBABILITY
ZONE | DAMAGE | COEFF.
0 | NONE | 0
1 | MINOR | 0.025
2 | MODERATE | 0.05
3 | MAJOR | 0.10
4 | GREAT | 0.15
35°
120°
90°

APPENDIX A

PHOTOGRAPHS TAKEN DURING INSPECTION

Lake Sherwood Dam

Photo 1.	-	View of the crest of the embankment.
Photo 2.	-	View of the upstream embankment slope.
Photo 3.	-	View of the downstream embankment slope.
Photo 4.	-	View of the intake to the left abutment spillway. Note the plugged pipe.
Photo 5.	-	View of the outlet of the left abutment spillway.
Photo 6.	-	View of the spillway discharge channel on the left abutment.
Photo 7.	-	View of the intake to the right abutment spillway.
Photo 8.	-	View of the outlet of the right abutment spillway.
Photo 9.	-	View of the concrete spillway discharge channel on the right abutment. Note the erosion on the left side of channel.
Photo 10.	-	View of the spillway discharge channel on the right abutment.
Photo 11.	-	View of the seepage in the bottom of the latrine structure on the crest of the downstream slope.
Photo 12.	-	View of the pipes in the downstream face of the latrine structure.
Photo 13.	-	View of the seepage at the downstream toe. Note rock wall in the background.
Photo 14.	-	View of the pipes in the rock wall at the downstream toe.
Photo 15.	-	View of the reservoir rim.

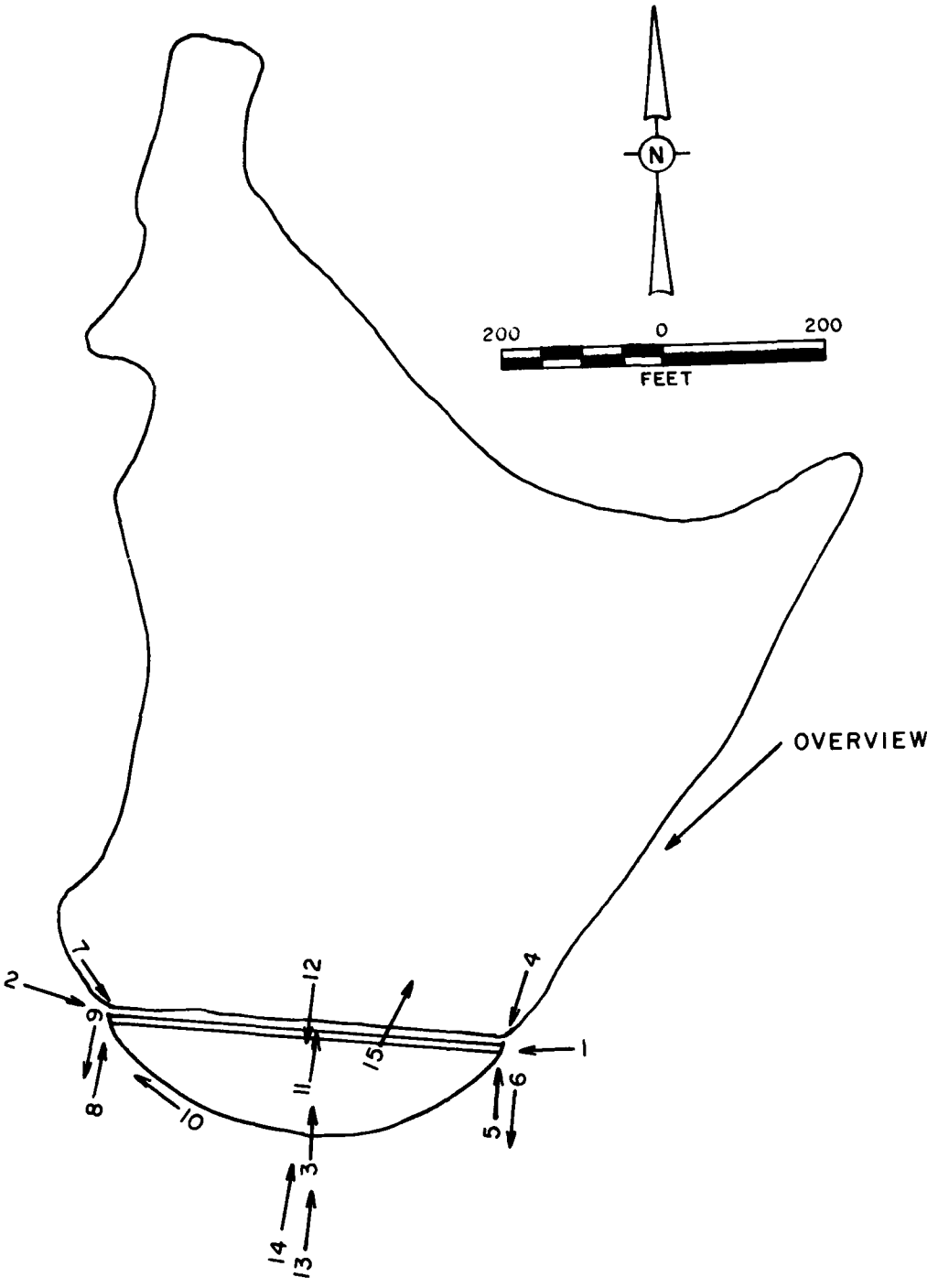


PHOTO INDEX
FOR
LAKE SHERWOOD DAM

Photo 1

Photo 2

Photo 5

Photo 6

Photo 7

Photo 8

Photo 9

Photo 10

Photo 11

Photo 12

Photo 13

Photo 14

Lake Sherwood Dam

Photo 15

APPENDIX B

HYDROLOGIC COMPUTATIONS

PLATE 1, APPENDIX B

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

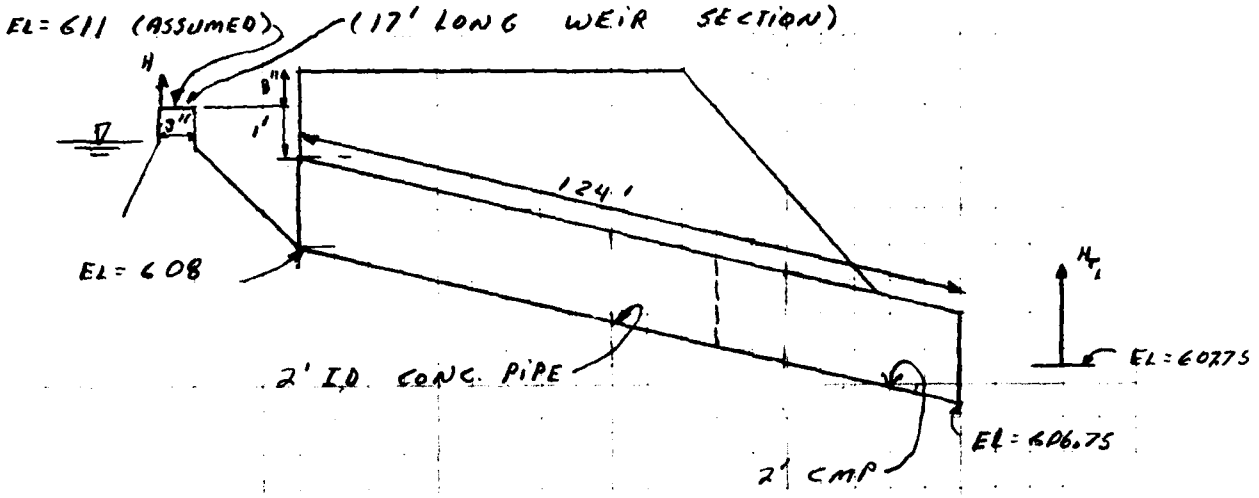
DRAINAGE BOUNDARY — — — —

LAKE SHERWOOD DAM (MO 11017)
DRAINAGE BASIN

B-2

DAM SAFETY INSPECTION - MISSOURI — SHEET NO. 1 OF
LAKE SHERWOOD DAM (11017) — JOB NO. 1240-001-1
SPILLWAY RATING CURVE DETERMINATION — BY KLB DATE 6-19-7

LEFT SPILLWAY



SPILLWAY DISCHARGE (ASSUME NO TAILWATER EFFECT)

AT WL. = 611.5

H_T = 611.5 - 607.75 = 3.75'
H_1 = 611.5 - 611.0 = 0.5'

a) WEIR FLOW:

Assume C = 3.0

$Q = CLH_1^{3/2} = 3.0 \times 17 \times 0.5^{3/2} = 18$ CFS.

b) CHECK PRESSURE FLOW

$H_T = \left(1 + K_e + f_1 \frac{L_1}{D_1} + f_2 \frac{L_2}{D}\right) \frac{V^2}{2g}$

Assume $\epsilon = 0.005$, $\frac{\epsilon}{D} = 0.0025 \Rightarrow f_1 = 0.025$ (for Conc.)
Assume $n = 0.027 \Rightarrow f_2 = 0.11$
Assume $K_e = 0.5$

$H_{T_1} = \left(1 + 0.5 + 0.11 \frac{62}{2} + 0.025 \frac{62}{2}\right) \frac{V^2}{2g}$

$H_{T_1} = 5.69 \frac{V^2}{2g}$, $\Rightarrow V = 3.36 \sqrt{H_{T_1}}$

$Q = A \cdot V = \pi 1^2 \times 3.36 \sqrt{H} = 10.57 \sqrt{H_{T_1}} = 10.57 \sqrt{0.75}$

$Q = 21$ cfs.

DAM SAFETY INSPECTION - MISSOURI SHEET NO. 2 OF

LAKE SHERWOOD DAM (11017) JOB NO. 1240-001-1

SPILLWAY RATING CURVE DETERMINATION BY KLB DATE 6-19-7?

LEFT SPILLWAY

AT W.L. = 611.5

WEIR FLOW CONTROLS $\Rightarrow Q =$ 18 CFS.

AT W.L. 612.0 $H_{T_1} = 612.0 - 607.75 = 4.25$

$H_1 = 612.0 - 611 = 1.00$

a) WEIR FLOW

$$Q = C L_1 H_1^{3/2} = 3.0 \times 17 \times 1^{3/2} = 51 \text{ CFS}$$

b) PRESSURE FLOW

$$Q = 10.57 \sqrt{H_{T_1}} = 10.57 \sqrt{4.25}$$

$Q =$ 22 CFS.

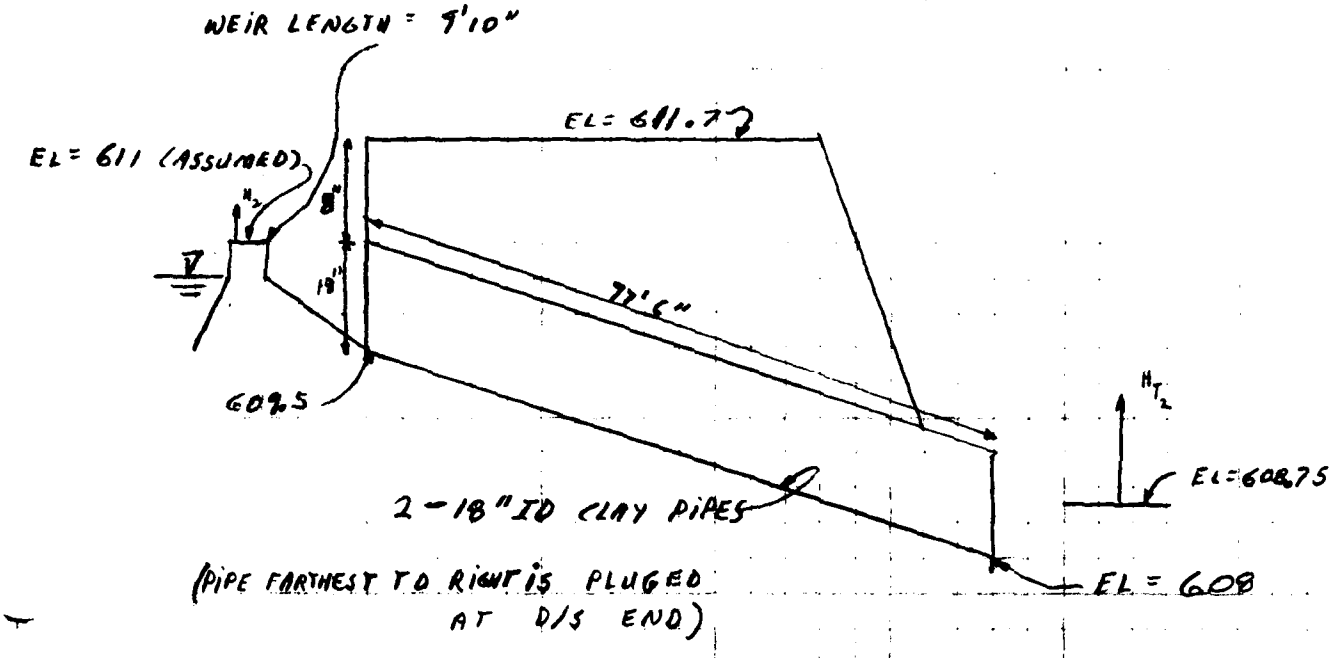
$\therefore$ AT ELEV. 612 PRESSURE FLOW CONTROLS

$\Rightarrow Q =$ 22 CFS.

ALSO FOR ALL ELEVATIONS ABOVE 612. PRESSURE FLOW WILL CONTROL AND THE EQUATION $Q_4 = 10.57 \sqrt{H_{T_1}}$ WILL BE USED.

DAM SAFETY INSPECTION - MISSOURI — SHEET NO. 3 OF
LAKE SHERWOOD DAM (11017) — JOB NO. 1240-001-1
SPILLWAY RATING CURVE DETERMINATION. — BY KLB DATE 6-19-7

RIGHT SPILLWAY



AT EL. 611.5 $H_{T_2} = 611.5 - 608.75 = 2.75'$, $H_1 = 0.5'$

a) WEIR FLOW ASSUME $C = 3.0$

$$Q = C L_2 H_2^{3/2} = 3.0 \times 9.83 \times 0.5^{3/2} = \underline{10 \text{ CFS}}$$

b) PRESSURE FLOW

$$H_T = \left(1.0 + K_e + f \frac{L}{D}\right) \frac{V^2}{2g}$$

Assume $n = 0.013 \rightarrow f = 0.027$; Assume $K_e = 0.5$

$$H_{T_2} = \left(1.5 + 0.027 \frac{99.5}{1.5}\right) \frac{V^2}{2g} = 3.29 \frac{V^2}{2g}$$

$$V = 4.42 \sqrt{H_{T_2}}, \quad Q = A \cdot V = \frac{\pi}{4}(1.5)^2 \times 4.42 \sqrt{H_{T_2}}$$

$$Q = 7.81 \sqrt{H_{T_2}}, \quad Q = 7.81 \sqrt{2.75} = \underline{13 \text{ CFS}}$$

DAM SAFETY INSPECTION - Missouri — SHEET NO. 4 OF
LAKE SHERWOOD DAM (11017) — JOB NO. 1240-001-1
SPILLWAY RATING CURVE DETERMINATION — BY KLB DATE 6-19-79

Prob 6-29-79

RIGHT SPILLWAY

AT ELEV. 615.5 WEIR FLOW CONTROLS

AND $Q = 10$ CFS.

AT ELEV. 612.0 $H_{T_2} = 612 - 608.75 = 3.25$

$H_2 = 612 - 611 = 1'$

a) WEIR FLOW

$Q = CLH^{3/2} = 3.0 \times 9.83 \times 1.0^{3/2} = \underline{29 \text{ CFS}}$

b) PRESSURE FLOW (ONE PIPE ONLY)

$Q = 7.81\sqrt{H_{T_2}} = 7.81\sqrt{3.25} = \underline{14}$ CFS.

∴ AT ELEV 612 PRESSURE FLOW CONTROLS

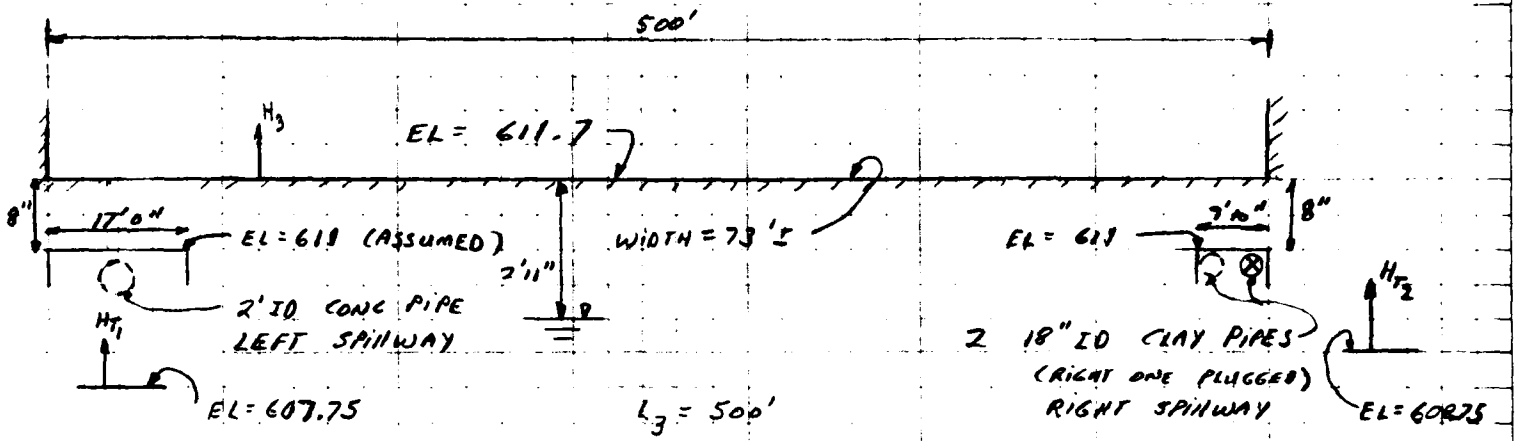
AND $Q = \underline{14}$ CFS

ALSO FOR AN ELEVATIONS ABOVE 612 PRESSURE FLOW WILL CONTROL AND THE EQUATION $Q_R = 7.81\sqrt{H_{T_2}}$ WILL BE USED.

DAM SAFETY INSPECTION - MISSOURI SHEET NO. 5 OF

LAKE SHERWOOD DAM JOB NO. 1240-001-1

SPILLWAY AND OVERTOP RATING CURVE BY KLB DATE 6-

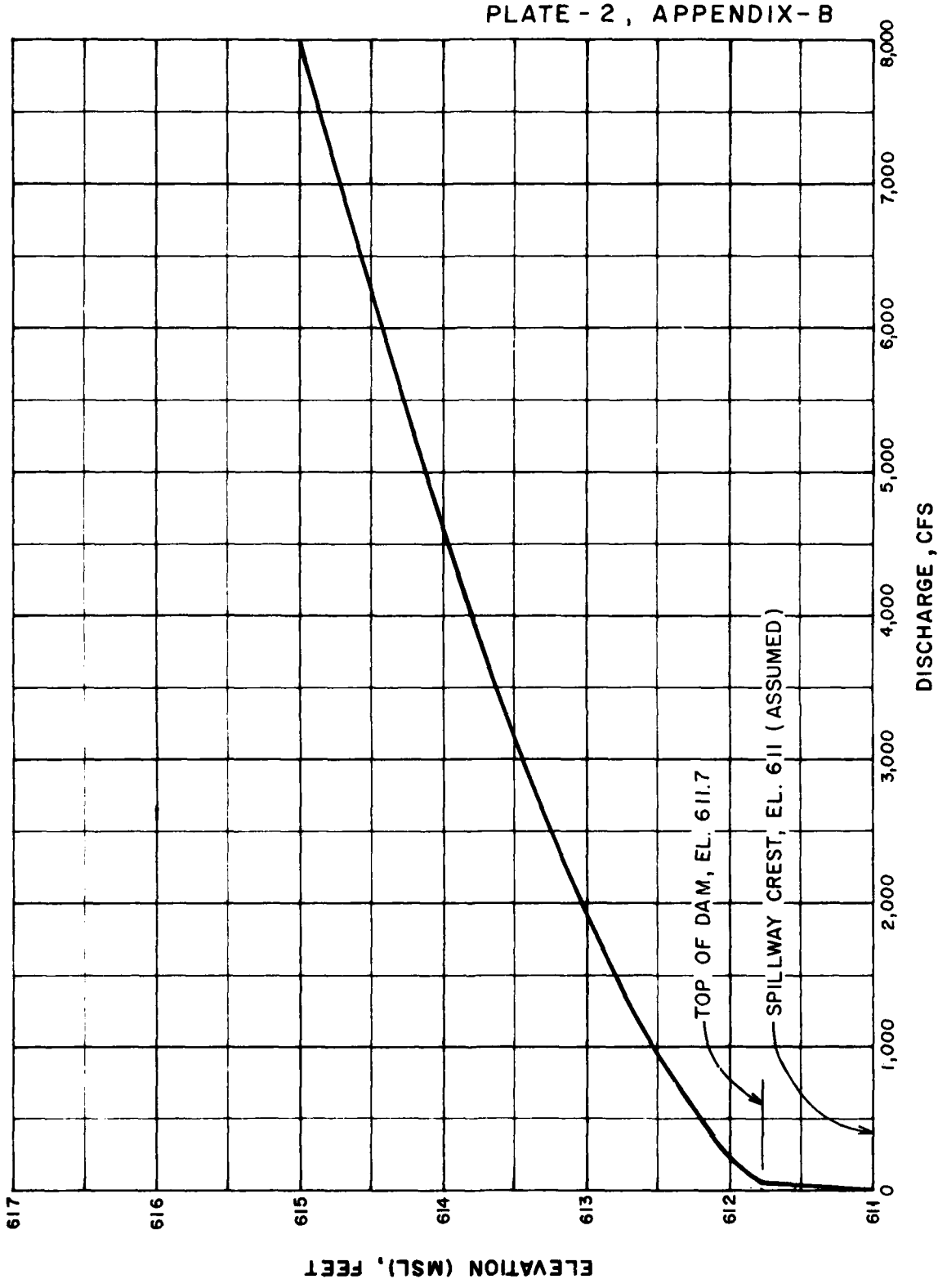


RESERVOIR W.S. ELEV.	H_{T_1}	LEFT SPILLWAY DISCHARGE $Q_L = 10.57\sqrt{H_{T_1}}$	H_{T_2}	RIGHT SPILLWAY DISCHARGE $Q_R = 7.81\sqrt{H_{T_2}}$	C_3	L_3	H_3	$Q_3 = C_3 L_3 H_3^{3/2}$	$Q_T = Q_L + Q_R + Q_3$
611.0	0	0	0	0	—	—	—	—	0
611.5	3.75	18 *	2.75	10 *	—	—	—	—	28
611.7	3.95	21	2.95	13	—	—	0	0	34
612.0	4.25	22	3.25	14	2.63	500	.3	216	252
613.0	5.25	24	4.25	16	2.63	500	1.3	1949	1989
614.0	6.25	26	5.25	18	2.63	500	2.3	4587	4,631
615.0	7.25	29	6.25	20	2.63	500	3.3	7883	7,932
618.0	8.25	30	7.25	21	2.63	500	4.3	11,725	11,776

* WEIR FLOW

8-7

PLATE - 2 , APPENDIX - B



LAKE SHERWOOD DAM (MO. 11017)
SPILLWAY & OVERTOP RATING CURVE

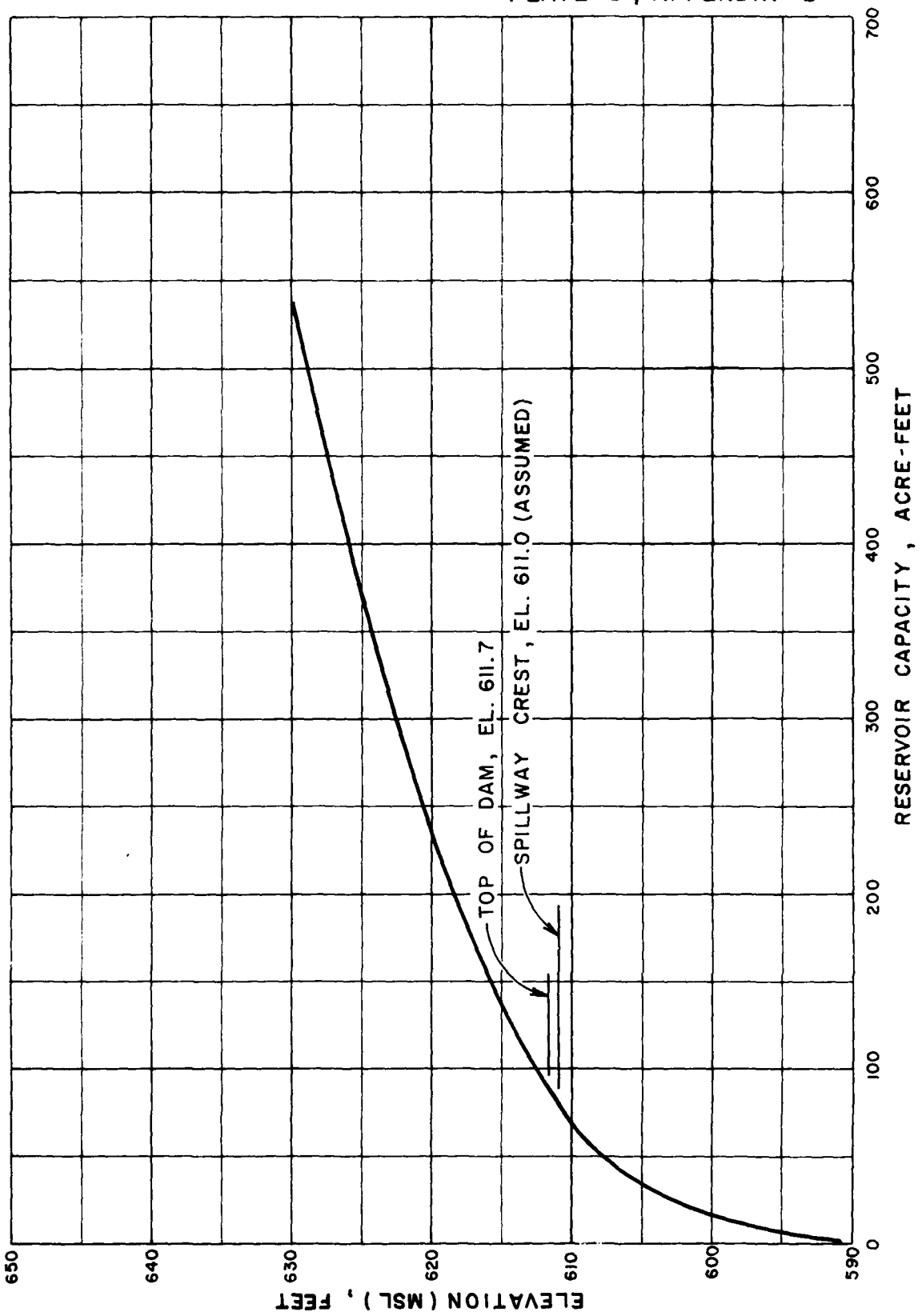
Dam Safety Inspection - Missouri SHEET NO. 1 OF
LAKE SHERWOOD DAM #110017 JOB NO. 1240
Reservoir Area Capacity BY M.R.H. D.N.E.J DATE 6-1-79

#110017

Reservoir Area Capacity

Elev. M.S.L. (Ft.)	Reservoir Surface Area (Acres)	Incremental Volume (Ac.-Ft.)	Total Volume (Ac.-Ft.)	Remarks
591	0	0	0	Est. Streambed Elev. at Dam
611	12	80	80	U.S. 23 shown on U.S.G.S. maps (Elev. Known) ASSUMED SPILLWAY CREST EL.
611.7	13	9	89	TOP OF DAM ELEV.
620	22	144	233	AREA MEASURED ON U.S.G.S. MAP.
630	38	296	529	AREA MEASURED ON U.S.G.S. MAP.

PLATE-3, APPENDIX-B



LAKE SHERWOOD DAM (MO. 11017)
RESERVOIR CAPACITY CURVE

DAM # MO. 11017

DETERMINATION OF PMP

1. DETERMINE DRAINAGE AREA OF BASIN

D. A. = 121 ACRES

2. DETERMINE PMP INDEX RAINFALL (200 SQ. MI. + 24 HRS DUR.)

LOCATION OF CENTROID BASIN

LONG. = 90° 21' 02" LAT. = 38° 41' 47"

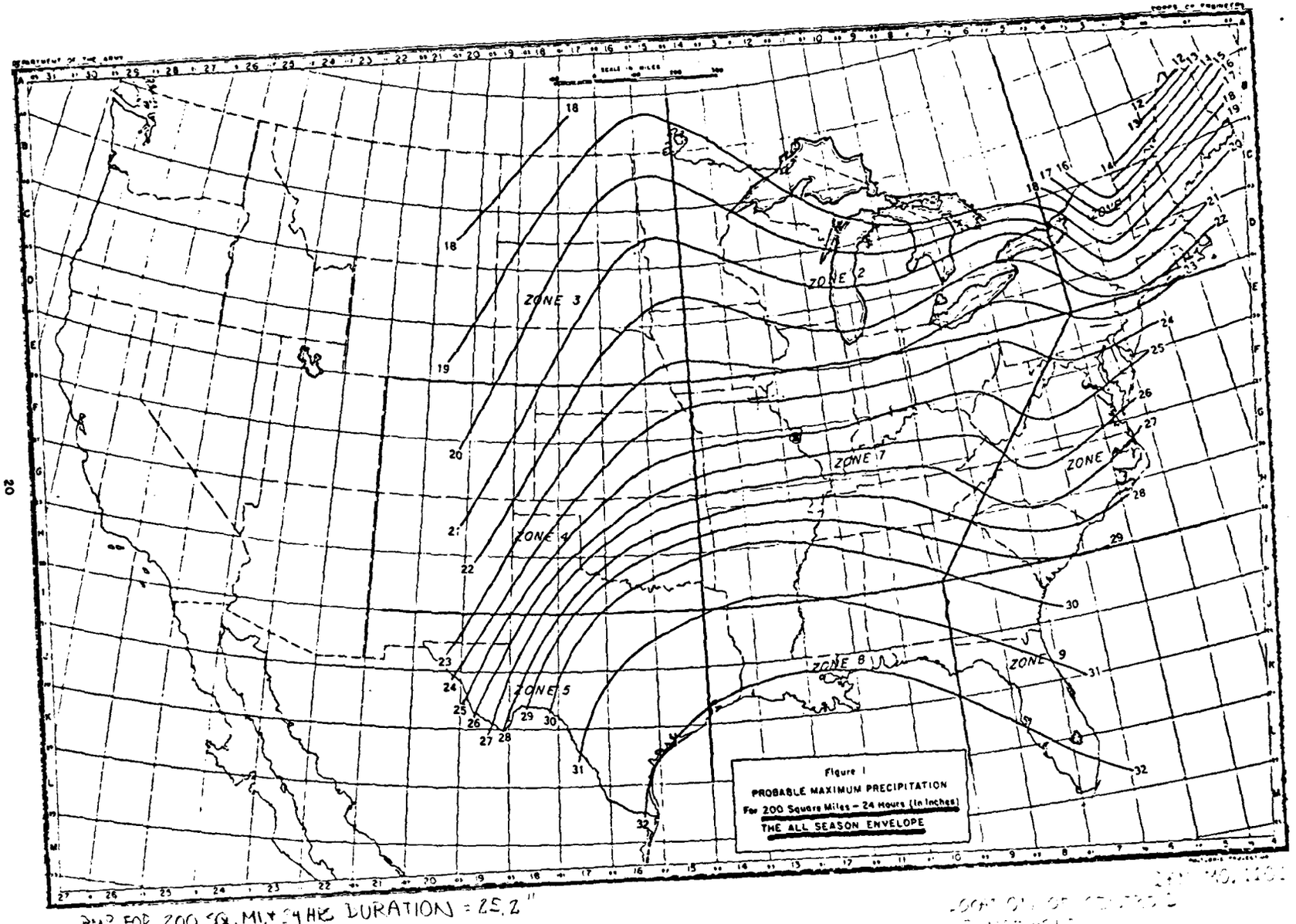
⇒ PMP = 25.2" (from Fig. 1, HMR #33)

3. DETERMINE BASIN RAINFALL IN TERMS OF PERCENTAGE OF PMP INDEX RAINFALL FOR VARIOUS DURATIONS:

LOCATION LONG = 90° 21' 02" LAT. = 38° 41' 47"

⇒ ZONE 7

DURATION (HOURS)	PERCENT OF INDEX RAINFALL	TOTAL RAINFALL (INCHES)	RAINFALL INCREMENTS	DURATION OF INCREMENTS
6	100	25.2	25.2	6
12	120	30.2	5.0	6
24	130	32.8	2.6	12



PMP FOR 200 SQ. MI. 24 HR DURATION = 25.2"

B-12

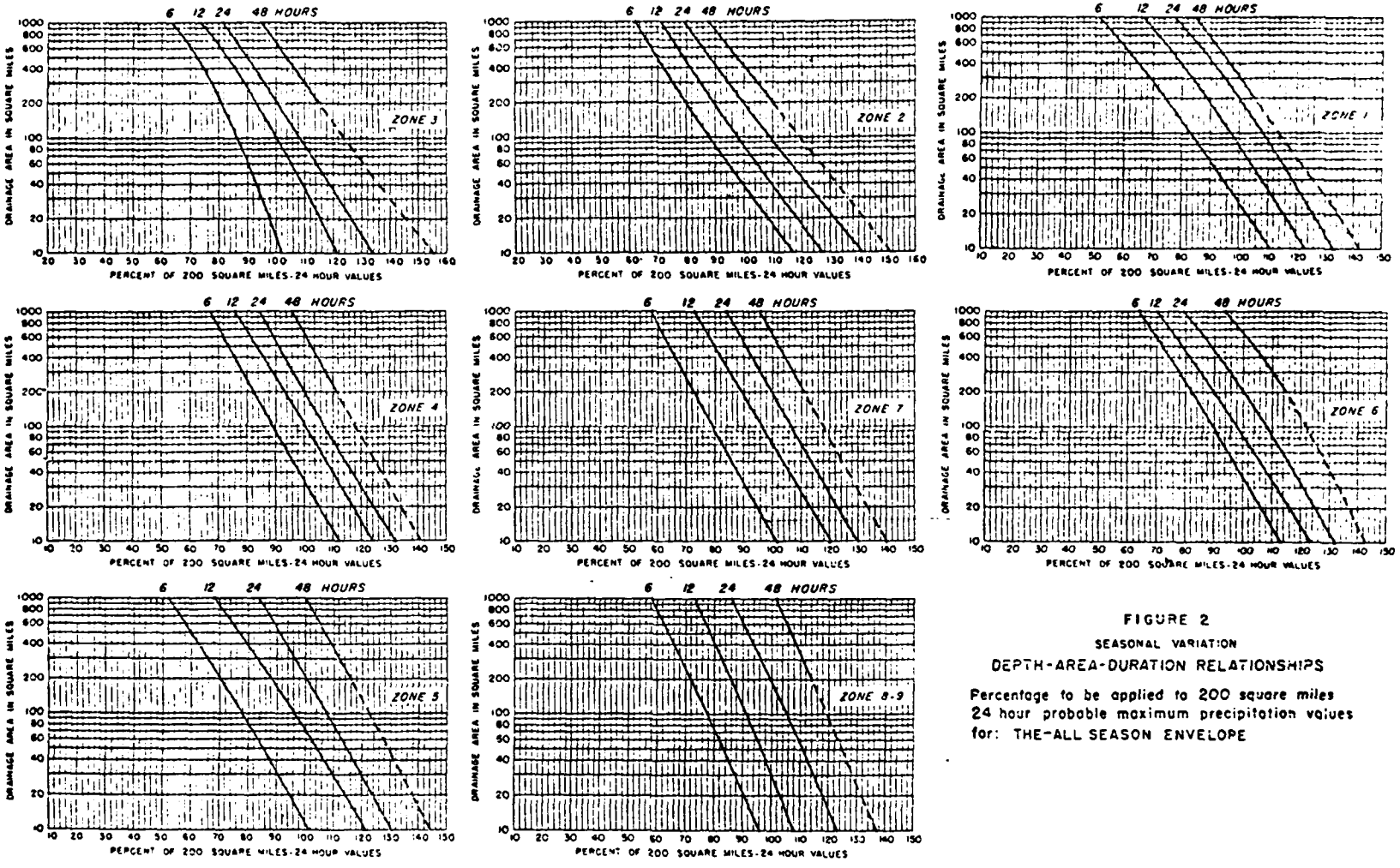


FIGURE 2

SEASONAL VARIATION

DEPTH-AREA-DURATION RELATIONSHIPS

Percentage to be applied to 200 square miles 24 hour probable maximum precipitation values for: THE-ALL SEASON ENVELOPE

DAM SAFETY INSPECTION - MISSOURI SHEET NO. 1 OF

LAKE SHERWOOD DAM # MO 11017 JOB NO. 1240

UNIT HYDROGRAPH PARAMETERS BY DNE DATE 2/11/

A.8 — 2 + 25

1. DRAINAGE AREA, A = 121 ACRES = 0.19 SQ MI

2. LENGTH OF STREAM, L_1 = 1400 ft = 0.27 mile.

3. ELEVATION AT DRAINAGE DIVIDE ALONG THE LONGEST STREAM: H_1 = 655 Ft

4. RESERVOIR ELEVATION AT SPILLWAY CREST, H_2 = 611 FT

5. DIFFERENCE IN ELEVATION, ΔH = 44 FT

6. AVERAGE SLOPE OF STREAM = $\frac{\Delta H}{L_1} = \frac{44}{1400} = 3.14\ \%$

7. TIME OF CONCENTRATION:

a) BY KIRPICH FORMULA:

$$T_c = \left(\frac{11.9 \times L^3}{\Delta H}\right)^{0.385} = \left(\frac{11.9 \times 0.27^3}{0.44}\right)^{0.385} = 0.13 \text{ HR}$$

b) BY VELOCITY ESTIMATE: AVG VEL = 4 FPS

$$T_c = \frac{L}{V} = \frac{1400}{3(60 \times 60)} = 0.13 \text{ HR}$$

USE T_c = 0.13

8. LAG TIME, $L_T = 0.6 \times 0.13 = 0.078$

9. UNIT DURATION, $D \leq \frac{L_T}{3} = \frac{0.078}{3} = 0.026 \leq 0.083$

USE D = 0.083

10. TIME TO PEAK, $T_P = \frac{D}{2} + L_T = \frac{0.083}{2} + 0.078 = 0.12$

11. PEAK DISCHARGE, $q_p = \frac{484A}{T_P} = \frac{484(0.19)}{0.12}$

q_p = 766 cfs.

LAKE SHERWOOD DAM (MO. 11017)

HYDROLOGIC SOIL GROUP & CURVE NUMBER

1. According to the General Soil Map of Missouri (11-30-77), watershed soils consist of Group 'B' soils.

2. The watershed area is urbanized. Assume 50 percent of the area as open space and the rest in residential development. Assume hydrologic condition of the watershed as 'Fair'.

   Thus $CN = \frac{69+72}{2} \simeq 71$ for Soil Group 'B' and AMC-II

   $\Rightarrow$ CN = 86 for Soil Group B & AMC-III.

HEC1DB INPUT DATA

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
SEP SAFETY VERSION  JULY 1978
 LAST MODIFICATION  28 FEB 79
**********
     1     I                                                                                                    SAFETY INSPECTION - MISSOURI
     2     I                                                                                                    LAKE SHER.(22) DAM (11017)
     3     I                                                                                                    PMF AS 50 PERCENT PMF DETERMINATION AND ROUTING
     4     I     500        0        5        0                 0        0        0        0        0        0
           I       1        5
           J       1        2        1
           J1      1     0.05
           K               11017                                                                    1
           K1  INPUT PRECIPITATION INDEX, RATIOS, AND UNIT HYDROGRAPH PARAMETERS
     1     I       1        2     1.15                    0.15      1.0
     11    I                    0.0      120      120      150
     12    I                                                                                    -1       -85
     13    J2                .074
     14    K       0        2        1
     15    I       1     11017                                        2        0        1
     16    K1  ROUTE HYDROGRAPH THROUGH LAKE SHER.(22) DAM (11017)
     17    K                                        1        1
     18    K1      1                                                                        -611       -1
     19    K2    611      611.5     11.7      512      613      614      615      616
     20    K6                       .74      252     1989     4041     7932    11770
     21    K7                        0        35      257      529
     22    K      591       11     611.7      62       63
     23    J1     611
     24    J2   611.7
     25    K     ...
```

B-17

REVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

ROUTE HYDROGRAPH AT 11017
ROUTE HYDROGRAPH TO 11017
END OF NETWORK

81-8

INFLOW PMF AND ONE-HALF PMF HYDROGRAPHS

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 197
 LAST MODIFICATION  26 FEB 79
**********

RUN   DATE= 79/07/17.
      TIME= 07.59.28.

                    DAM SAFETY INSPECTION - MISSOURI
                    LAKE SHERWOOD DAM (11017)
                    PMF AND 50 PERCENT PMF DETERMINATION AND ROUTING

                                  JO  SPECIFICATION
      NMIN      IDAY      IHR      MIN    METRIC    IPLT    IPRT    NSTAN
         5         0        0        0         0       1       0        0
                JOPER      NUT    LROPT    TRACE
                    0        0        0        0

                    MULTI-PLAN ANALYSES TO BE PERFORMED
                    NPLAN= 1  NRTIO= 2  LRTIO= 1

                    RTIOS=  1.00   .50

**********  **********  **********  **********  **********

                    SUB-AREA RUNOFF COMPUTATION

                    INPUT PRECIPITATION INDEX, RATIOS, AND UNIT HYDROGRAPH PARAMETERS

                ISTAQ   ICOMP   IECON   ITAPE   JPLT    JPRT   INAME  ISTAGE  IAUTO
                11017               0       0       0       0       1       0       0

                                  HYDROGRAPH DATA
          IHYDG      IUHG     TAREA    SNAP    TRSDA    TRSPC    RATIO  ISNOW  ISAME  LOCAL
              1         0       .19    0.00      .19     1.00    0.000      0      0      0

                                  PRECIP DATA
                SPFE     PMS      R6      R12     R24     R48     R72     R96
                0.00   25.20   100.00  100.00  100.00    0.00    0.00    0.00

                                  LOSS DATA
          LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOR   STRTL   CNSTL   ALSMX   RTIMP
              0    0.00    0.00    1.00    0.00    0.00    1.00   -1.00  -96.00    0.00    0.00

          CURVE NO =  -96.00  WETNESS =   -1.00  EFFECT OF =   96.00

                                  UNIT HYDROGRAPH DATA
                          TC=  0.00    LAG=   .00

                                  RECESSION DATA
                          STRTQ=   0.00    QRCSN=   0.00    RTIOR= 1.00

          TIME INCREMENT FOR LAG/C--(MIN) IS GT LAG/20

          UNIT HYDROGRAPH  7 END-OF-PERIOD ORDINATES, TC=   0.00 HOURS, LAG=   .00  VOL= 1.01
```

610.	[illegible]	165.	59.	19.	7.	1.

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	0.00	.01	0.	1.01	12.35	151	.21	.20	.01	298.
1.01	.10	2	.01	0.00	.01	0.	1.01	12.40	152	.21	.20	.01	298.
1.01	.15	3	.01	0.00	.01	0.	1.01	12.45	153	.21	.20	.01	299.
1.01	.20	4	.01	0.00	.01	0.	1.01	12.50	154	.21	.20	.01	299.
1.01	.25	5	.01	0.00	.01	0.	1.01	12.55	155	.21	.20	.01	300.
1.01	.30	6	.01	0.00	.01	0.	1.01	13.00	156	.21	.25	.01	[illegible]
1.01	.35	7	.01	0.00	.01	0.	1.01	13.05	157	.25	.25	.01	325.
1.01	.40	8	.01	0.00	.01	0.	1.01	13.10	158	.25	.25	.01	350.
1.01	.45	9	.01	0.00	.01	0.	1.01	13.15	159	.25	.25	.01	358.
1.01	.50	10	.01	0.00	.01	0.	1.01	13.20	160	.25	.25	.01	361.
1.01	.55	11	.01	0.00	.01	0.	1.01	13.25	161	.25	.25	.01	362.
1.01	1.00	12	.01	0.00	.01	0.	1.01	13.30	162	.25	.25	.01	362.
1.01	1.05	13	.01	0.00	.01	0.	1.01	13.35	163	.25	.25	.01	363.
1.01	1.10	14	.01	0.00	.01	0.	1.01	13.40	164	.25	.25	.00	363.
1.01	1.15	15	.01	0.00	.01	0.	1.01	13.45	165	.25	.25	.00	364.
1.01	1.20	16	.01	0.00	.01	0.	1.01	13.50	166	.25	.25	.00	364.
1.01	1.25	17	.01	0.00	.01	0.	1.01	13.55	167	.25	.25	.00	364.
1.01	1.30	18	.01	0.00	.01	0.	1.01	14.00	168	.25	.25	.00	364.
1.01	1.35	19	.01	0.00	.01	0.	1.01	14.05	169	.32	.31	.01	402.
1.01	1.40	20	.01	0.00	.01	0.	1.01	14.10	170	.32	.31	.00	439.
1.01	1.45	21	.01	0.00	.01	0.	1.01	14.15	171	.32	.31	.00	451.
1.01	1.50	22	.01	0.00	.01	0.	1.01	14.20	172	.32	.31	.00	455.
1.01	1.55	23	.01	0.00	.01	0.	1.01	14.25	173	.32	.31	.00	457.
1.01	2.00	24	.01	.00	.01	0.	1.01	14.30	174	.32	.31	.00	457.
1.01	2.05	25	.01	.00	.01	[illegible]	1.01	14.35	175	.32	.31	.00	458.
1.01	2.10	26	.01	.00	.01	1.	1.01	14.40	176	.32	.31	.00	458.
1.01	2.15	27	.01	.00	.01	1.	1.01	14.45	177	.32	.31	.00	458.
1.01	2.20	28	.01	.00	.01	1.	1.01	14.50	178	.32	.31	.00	458.
1.01	2.25	29	.01	.00	.01	1.	1.01	14.55	179	.32	.31	.00	458.
1.01	2.30	30	.01	.00	.01	2.	1.01	15.00	180	.32	.31	.00	459.
1.01	2.35	31	.01	.00	.01	2.	1.01	15.05	181	.19	.19	.00	384.
1.01	2.40	32	.01	.00	.01	2.	1.01	15.10	182	.38	.38	.00	428.
1.01	2.45	33	.01	.00	.01	3.	1.01	15.15	183	.38	.38	.00	517.
1.01	2.50	34	.01	.00	.01	3.	1.01	15.20	184	.57	.57	.00	661.
1.01	2.55	35	.01	.00	.01	3.	1.01	15.25	185	.67	.67	.01	940.
1.01	3.00	36	.01	.00	.01	4.	1.01	15.30	186	1.63	1.62	.01	1515.
1.01	3.05	37	.01	.00	.01	4.	1.01	15.35	187	2.68	2.67	.01	2746.
1.01	3.10	38	.01	.00	.01	4.	1.01	15.40	188	1.15	1.15	.00	3563.
1.01	3.15	39	.01	.00	.01	4.	1.01	15.45	189	.57	.57	.00	1632.
1.01	3.20	40	.01	.00	.02	5.	1.01	15.50	190	.57	.57	.00	1131.
1.01	3.25	41	.01	.00	.01	5.	1.01	15.55	191	.38	.38	.00	818.
1.01	3.30	42	.01	.00	.01	5.	1.01	16.00	192	.38	.38	.00	643.
1.01	3.35	43	.01	.00	.01	5.	1.01	16.05	193	.29	.29	.00	530.
1.01	3.40	44	.01	.00	.01	5.	1.01	16.10	194	.29	.29	.00	461.
1.01	3.45	45	.01	.00	.01	6.	1.01	16.15	195	.29	.29	.00	440.
1.01	3.50	46	.01	.00	.01	6.	1.01	16.20	196	.29	.29	.00	433.
1.01	3.55	47	.01	.00	.01	6.	1.01	16.25	197	.29	.29	.00	431.
1.01	4.00	48	.01	.00	.01	6.	1.01	16.30	198	.29	.29	.00	431.
1.01	4.05	49	.01	.00	.01	7.	1.01	16.35	199	.29	.29	.00	431.
1.01	4.10	50	.01	.00	.01	7.	1.01	16.40	200	.29	.29	.00	431.
1.01	4.15	51	.01	.00	.01	7.	1.01	16.45	201	.29	.29	.00	431.
1.01	4.20	52	.01	.00	.01	7.	1.01	16.50	202	.29	.29	.00	431.
1.01	4.25	53	.01	.01	.01	7.	1.01	16.55	203	.29	.29	.00	431.
1.01	4.30	54	.01	.01	.01	7.	1.01	17.00	204	.29	.29	.00	431.
1.01	4.35	55	.01	.01	.01	8.	1.01	17.05	205	.23	.23	.00	393.

1.01	4.40	56	.01	.01	.01	7.	1.01	17.10	206	.03	.03	.00	356.
1.01	4.45	57	.01	.01	.01	7.	1.01	17.15	207	.03	.03	.00	344.
1.01	4.50	58	.01	.01	.01	8.	1.01	17.20	208	.03	.03	.00	340.
1.01	4.55	59	.01	.01	.01	8.	1.01	17.25	209	.03	.03	.00	339.
1.01	5.00	60	.01	.01	.01	8.	1.01	17.30	210	.03	.03	.00	339.
1.01	5.05	61	.01	.01	.01	9.	1.01	17.35	211	.03	.03	.00	339.
1.01	5.10	62	.01	.01	.01	9.	1.01	17.40	212	.03	.03	.00	339.
1.01	5.15	63	.01	.01	.01	9.	1.01	17.45	213	.03	.03	.00	339.
1.01	5.20	64	.01	.01	.01	9.	1.01	17.50	214	.03	.03	.00	339.
1.01	5.25	65	.01	.01	.01	9.	1.01	17.55	215	.03	.03	.00	339.
1.01	5.30	66	.01	.01	.01	10.	1.01	18.00	216	.03	.03	.00	339.
1.01	5.35	67	.01	.01	.01	10.	1.01	18.05	217	.02	.02	.00	211.
1.01	5.40	68	.01	.01	.01	10.	1.01	18.10	218	.02	.02	.00	98.
1.01	5.45	69	.01	.01	.01	10.	1.01	18.15	219	.02	.02	.00	49.
1.01	5.50	70	.01	.01	.01	10.	1.01	18.20	220	.02	.02	.00	36.
1.01	5.55	71	.01	.01	.01	10.	1.01	18.25	221	.02	.02	.00	32.
1.01	6.00	72	.01	.01	.01	10.	1.01	18.30	222	.02	.02	.00	31.
1.01	6.05	73	.02	.04	.05	28.	1.01	18.35	223	.02	.02	.00	31.
1.01	6.10	74	.02	.04	.05	47.	1.01	18.40	224	.02	.02	.00	31.
1.01	6.15	75	.02	.04	.05	64.	1.01	18.45	225	.02	.02	.00	31.
1.01	6.20	76	.02	.04	.05	64.	1.01	18.50	226	.02	.02	.00	31.
1.01	6.25	77	.02	.04	.05	64.	1.01	18.55	227	.02	.02	.00	31.
1.01	6.30	78	.02	.04	.05	64.	1.01	19.00	228	.02	.02	.00	31.
1.01	6.35	79	.02	.04	.05	64.	1.01	19.05	229	.02	.02	.00	31.
1.01	6.40	80	.02	.04	.05	64.	1.01	19.10	230	.02	.02	.00	31.
1.01	6.45	81	.02	.04	.05	64.	1.01	19.15	231	.02	.02	.00	31.
1.01	6.50	82	.02	.04	.05	71.	1.01	19.20	232	.02	.02	.00	31.
1.01	6.55	83	.02	.04	.05	75.	1.01	19.25	233	.02	.02	.00	31.
1.01	7.00	84	.02	.04	.05	76.	1.01	19.30	234	.02	.02	.00	31.
1.01	7.05	85	.02	.04	.05	76.	1.01	19.35	235	.02	.02	.00	31.
1.01	7.10	86	.02	.04	.05	76.	1.01	19.40	236	.02	.02	.00	31.
1.01	7.15	87	.02	.04	.05	77.	1.01	19.45	237	.02	.02	.00	31.
1.01	7.20	88	.02	.04	.05	78.	1.01	19.50	238	.02	.02	.00	31.
1.01	7.25	89	.02	.04	.05	78.	1.01	19.55	239	.02	.02	.00	31.
1.01	7.30	90	.02	.04	.05	81.	1.01	20.00	240	.02	.02	.00	31.
1.01	7.35	91	.02	.04	.05	81.	1.01	20.05	241	.02	.02	.00	31.
1.01	7.40	92	.02	.04	.05	82.	1.01	20.10	242	.02	.02	.00	31.
1.01	7.45	93	.02	.04	.05	83.	1.01	20.15	243	.02	.02	.00	31.
1.01	7.50	94	.02	.04	.05	84.	1.01	20.20	244	.02	.02	.00	31.
1.01	7.55	95	.02	.04	.05	84.	1.01	20.25	245	.02	.02	.00	31.
1.01	8.00	96	.02	.04	.05	85.	1.01	20.30	246	.02	.02	.00	31.
1.01	8.05	97	.02	.04	.05	86.	1.01	20.35	247	.02	.02	.00	31.
1.01	8.10	98	.02	.04	.05	86.	1.01	20.40	248	.02	.02	.00	31.
1.01	8.15	99	.02	.04	.05	87.	1.01	20.45	249	.02	.02	.00	31.
1.01	8.20	100	.02	.04	.05	87.	1.01	20.50	250	.02	.02	.00	31.
1.01	8.25	101	.02	.04	.05	87.	1.01	20.55	251	.02	.02	.00	31.
1.01	8.30	102	.02	.04	.05	88.	1.01	21.00	252	.02	.02	.00	31.
1.01	8.35	103	.02	.04	.05	89.	1.01	21.05	253	.02	.02	.00	31.
1.01	8.40	104	.02	.04	.05	89.	1.01	21.10	254	.02	.02	.00	31.
1.01	8.45	105	.02	.04	.05	90.	1.01	21.15	255	.02	.02	.00	31.
1.01	8.50	106	.02	.04	.05	90.	1.01	21.20	256	.02	.02	.00	31.
1.01	8.55	107	.02	.04	.05	90.	1.01	21.25	257	.02	.02	.00	31.
1.01	9.00	108	.02	.04	.05	91.	1.01	21.30	258	.02	.02	.00	31.
1.01	9.05	109	.02	.04	.05	91.	1.01	21.35	259	.02	.02	.00	31.
1.01	9.10	110	.02	.04	.05	91.	1.01	21.40	260	.02	.02	.00	31.
1.01	9.15	111	.02	.04	.05	92.	1.01	21.45	261	.02	.02	.00	31.
1.01	9.20	112	.02	.04	.05	92.	1.01	21.50	262	.02	.02	.00	31.
1.01	9.25	113	.02	.04	.05	93.	1.01	21.55	263	.02	.02	.00	31.
1.01	9.30	114	.02	.04	.05	93.	1.01	22.00	264	.02	.02	.00	31.
1.01	9.35	115	.02	.04	.05	93.	1.01	22.05	265	.02	.02	.00	31.

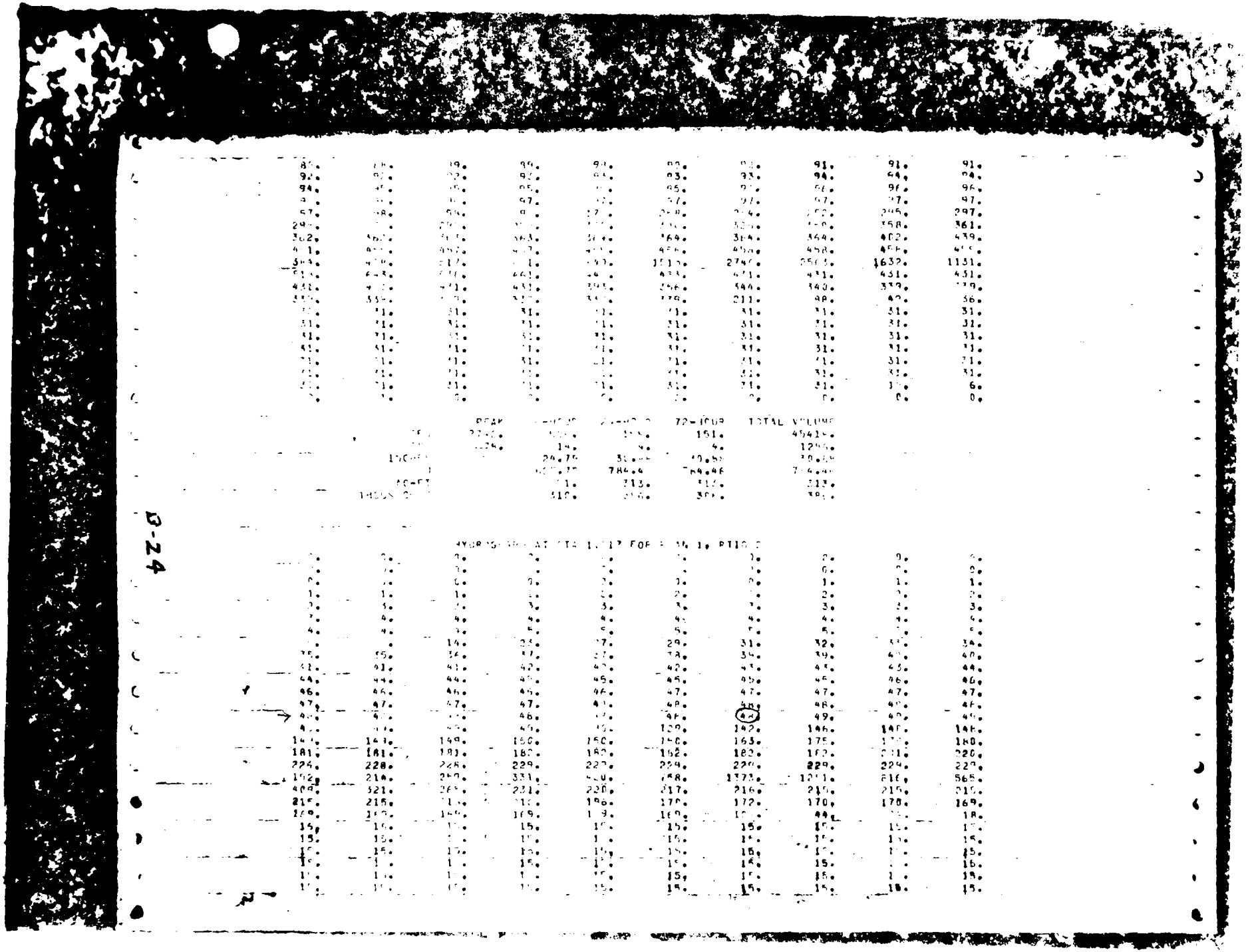
1.01	10.15	123	.07	.09	.01	95.	1.01	22.40	274	.02	.02	.00	31.
1.01	10.20	124	.07	.09	.01	95.	1.01	22.45	274	.02	.02	.00	31.
1.01	10.25	125	.07	.09	.01	95.	1.01	22.50	275	.02	.02	.00	31.
1.01	10.30	126	.07	.09	.01	95.	1.01	22.55	276	.02	.02	.00	31.
1.01	10.35	127	.07	.09	.01	95.	1.01	23.00	277	.02	.02	.00	31.
1.01	10.40	128	.07	.09	.00	96.	1.01	23.05	278	.02	.02	.00	31.
1.01	10.45	129	.07	.09	.00	96.	1.01	23.10	279	.02	.02	.00	31.
1.01	10.50	130	.07	.09	.00	96.	1.01	23.15	280	.02	.02	.00	31.
1.01	10.55	131	.07	.09	.00	96.	1.01	23.20	281	.02	.02	.00	31.
1.01	11.00	132	.07	.09	.00	96.	1.01	23.25	282	.02	.02	.00	31.
1.01	11.05	133	.07	.09	.00	96.	1.01	23.30	283	.02	.02	.00	31.
1.01	11.10	134	.07	.09	.00	96.	1.01	23.35	284	.02	.02	.00	31.
1.01	11.15	135	.07	.09	.00	97.	1.01	23.40	285	.02	.02	.00	31.
1.01	11.20	136	.07	.09	.00	97.	1.01	23.45	286	.02	.02	.00	31.
1.01	11.25	137	.07	.09	.00	97.	1.01	23.50	287	.02	.02	.00	31.
1.01	11.30	138	.07	.09	.00	97.	1.01	23.55	288	.02	.02	.00	31.
1.01	11.35	139	.07	.09	.00	97.	1.02	0.00	289	0.00	0.00	0.00	10.
1.01	11.40	140	.07	.09	.00	97.	1.02	0.05	289	0.00	0.00	0.00	6.
1.01	11.45	141	.07	.09	.00	97.	1.02	0.10	289	0.00	0.00	0.00	2.
1.01	11.50	142	.07	.09	.00	97.	1.02	0.15	289	0.00	0.00	0.00	1.
1.01	11.55	143	.07	.09	.00	97.	1.02	0.20	289	0.00	0.00	0.00	0.
1.01	12.00	144	.07	.09	.00	97.	1.02	0.25	289	0.00	0.00	0.00	0.
1.01	12.05	145	.07	.09	.01	97.	1.02	0.30	289	0.00	0.00	0.00	0.
1.01	12.10	146	.07	.09	.01	97.	1.02	0.35	289	0.00	0.00	0.00	0.
1.01	12.15	147	.07	.09	.01	97.	1.02	0.40	289	0.00	0.00	0.00	0.
1.01	12.20	148	.07	.09	.01	297.	1.02	0.45	289	0.00	0.00	0.00	0.
1.01	12.25	149	.07	.09	.01	297.	1.02	0.50	289	0.00	0.00	0.00	0.
1.01	12.30	150	.07	.09	.01	297.	1.02	0.55	289	0.00	0.00	0.00	0.

SUM 32.76 31.18 1.44 .45431.
(832.)(794.)(49.)(1286.46)

	PEAK	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	27.	159.	159.	45431.
CMS	7.	4.	4.	1286.
INCHES		24.79	30.88	30.88
MM		629.72	784.46	784.46
AC-FT		251.	313.	313.
THOUS CU M		310.	386.	386.

HYDROGRAPH AT STA 11017 FOR PLAN 1, RTIO 1

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	1.	1.	1.	1.	2.
2.	3.	3.	3.	4.	4.	4.	4.	5.	5.
5.	6.	6.	6.	6.	6.	7.	7.	7.	7.
7.	7.	7.	7.	8.	8.	8.	8.	8.	8.
9.	9.	9.	9.	9.	9.	10.	10.	10.	10.
10.	10.	34.	47.	59.	68.	71.	64.	65.	67.
69.	71.	72.	74.	75.	76.	77.	78.	79.	80.
81.	82.	83.	84.	85.	85.	86.	86.	87.	87.



D-24

SUMMARY OF PMF AND ONE-HALF PMF FLOOD ROUTING

PEAK FLOW AND STORAGE (END-OF-PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOW IS CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1	RATIO 2
				1.00	.50
HYDROGRAPH AT	11.17	.19	1	796.	1774.
	(	.49)	(	77.7) (	50.2) (
ROUTED TO	1101	.1	1	2152.	1001.
	(	.49)	(	60.9) (	28.3) (

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	611.00	611.00	611.70
STORAGE	90.	0.	89.
OUTFLOW	0.	0.	34.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	615.[illegible]	1.[illegible]	11[illegible].	2152.	11.42	15.67	6.30
.	610.[illegible]	.[illegible]	1[illegible].	1053.	7.08	15.67	0.00

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PERCENT OF PMF FLOOD ROUTING
EQUAL TO SPILLWAY CAPACITY

PREVIOUS OF SEQUENCE OF STREAM NETWORK CALCULATIONS

RUNOFF HYDROGRAPH AT 11017
ROUTE HYDROGRAPH TO 11017
END OF NETWORK

FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 1 FEB 79

RUN DATE = 7/27/79
TIME = 10:41:

DAM SAFETY INSPECTION - MISSOURI
LAKE SHERWOOD DAM (11017)
PERCENT PMF DETERMINATION AND ROUTING

JOB SPECIFICATION

NO	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
			0	0	0	0	0	0	0
			JOPER	NWT	LROPT	TRACE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 RATIO= 0 LRTIO= 1
RTIOS= .05 .06 .07 .08 .09 .10 .11 .12 .13

SUB-AREA RUNOFF COMPUTATION

INPUT PRECIPITATION INDEX, RATIO, AND UNIT HYDROGRAPH PARAMETERS

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
11017	0	0	3	0	3	1	0	0

HYDROGRAPH DATA

IHYD	IUHG	TAREA	SNAP	IPSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1		.19	0.00	.19	1.00	0.000		0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	25.70	100.00	1[illegible].00	1[illegible].00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
	0.0	0.0	1.00	0.00	0.00	1.00	-1.00	-86.00	0.00	0.00

CURVE NO = -86.00 WETNESS = -1.00 EFFECT CN = 86.00

UNIT HYDROGRAPH DATA
TC= 0.00 LAG= .00

RECESSION DATA
STRTQ= 0.00 QRCSN= 0.00 RTIOR= 1.00

END-OF-PERIOD FLOW

HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q

SUM 30.76 30.66 1.08 4431.
(832.) (784.) (.) 1286.46)

HYDROGRAPH ROUTING

HYDROGRAPH THROUGH LAKE SHERWOOD (11C17)

ITAP	ICOMP	ICON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
11.17	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.0	2	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-611.	-1

STAGE	611.00	611.00	611.77	612.00	613.00	614.00	615.00	616.00
FLOW	0.00	24.00	34.00	0.00	1100.00	4621.00	7980.00	11776.00
CAPACITY=	0.	0.	49.	332.	629.			
EXCESS	0.	611.	612.	612.	650.			

ELEV	SPIL	CREL	EXPO	FLEVL	COOL	CAREA	EXPL
611.0	0.0	.0	0.0	0.0	0.0	0.0	0.

DAM DATA

TFEL	COEF	EXPD	DAMWID
611.7	3.0	.0	0.

PEAK OUTFLOW IS 27. AT TIME 17.00 HOURS

PEAK OUTFLOW IS 31. AT TIME 17.00 HOURS

PEAK OUTFLOW IS 34. AT TIME 17.17 HOURS

PEAK OUTFLOW IS 84. AT TIME 17.92 HOURS

PEAK OUTFLOW IS 92. AT TIME 17.92 HOURS

PEAK OUTFLOW IS 121. AT TIME 17.92 HOURS

PEAK OUTFLOW IS 149. AT TIME 17.92 HOURS

PEAK OUTFLOW IS 174. AT TIME 17.92 HOURS

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PEAK (CFS) A[illegible] AREA (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1 .06	RATIO 2 .06	RATIO 3 .07	RATIO 4 .08	RATIO 5 .09	RATIO 6 .10	RATIO 7 .11	RATIO 8 .12	RATIO 9 .13
HYDROGRAPH AT	11017	.19	1	13.	16.	192.	220.	247.	275.	302.	330.	357.
		(.49)		(.36)(	4.47)(	5.48)(	6.23)(	7.00)(	7.79)(	8.55)(	9.33)(	10.11)
ROUTED TO	11017	.19	1	07.	35.	74.	69.	93.	121.	147.	175.	201.
		(.49)		(.77)(	.97)(	.75)(	1.70)(	2.59)(	3.45)(	4.18)(	4.95)(	5.69)

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SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	611.00	611.00	611.00
STORAGE	0.	0.	49.
OUTFLOW	0.	0.	42.

RATIO OF PMF	MAXIMUM RESERVOIR W.S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.05	611.09	0.00	86.	37.	0.00	16.08	0.00
.07	611.09	0.00	85.	37.	0.00	16.08	0.00
.09	611.	0.00	80.	34.	0.00	16.17	0.00
.1	611.14	0.14	96.	68.	1.42	16.92	0.00
.03	611.28	0.28	98.	92.	1.75	16.83	0.00
.15	611.	0.30	91.	121.	2.42	16.83	0.00
.11	611.	0.31	92.	147.	2.58	16.83	0.00
.1	611.45	0.45	93.	175.	2.67	16.75	0.00
.13	611.53	0.53	93.	201.	2.83	16.75	0.00


DATE
ILME